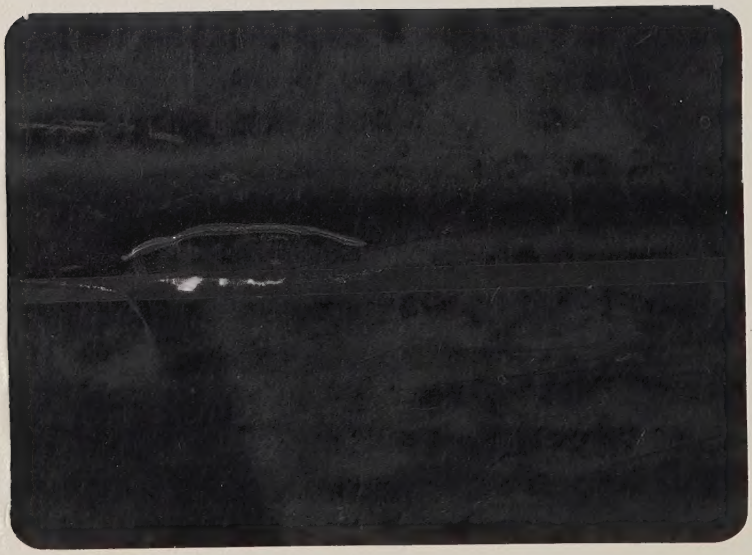
GenRad

SEL
SE LABS

Instruction Manual

Rev 7-5-94



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Handbook of Noise Measurement

This book, by Dr. A. P. G. Peterson and Ervin E. Gross, Jr., of the GenRad Engineering Staff covers thoroughly the subject of noise and vibration measurement. Copies are available from GenRad at $7.50 each, postpaid in the United States.

GR 1383 Random-Noise Generator

Form 1383-0100-C

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Concord, Massachusetts, U.S.A. 01742
October 1977
ID-0100

Specifications

Spectrum: Flat (constant energy per hertz of bandwidth) ±1 dB from 20 Hz to 10 MHz, ±1.5 dB from 10 MHz to 20 MHz.

Waveform: Table shows amplitude-density-distribution specifications of generator compared with the Gaussian probability-density function, as measured in a "window" of 0.2σ, centered on the indicated values:

Voltage	Gaussian Prob. Dens. Function	Amplitude-Density Dist. of 1383 Random-Noise Gen.
0	0.0796	0.0796 ±0.005
±σ	0.0484	0.0484 ±0.005
±2σ	0.0108	0.0108 ±0.003
±3σ	0.000898	0.000898 ±0.0003

(σ is the standard deviation or rms value of the noise voltage.)

Output Voltage: At least 1 V rms max , open circuit.

Output Meter: Indicates open-circuit output voltage ahead of 50Ω.

Output Impedance: 50Ω. Can be shorted without causing distortion.

Amplitude Control: Continuous control and 8-step, 10 dB-per-step attenuator.

Output Terminals: GR874® coaxial connector that can be mounted on either front or rear panel.

Accessories Supplied: Spare fuses, lamp, power cord.

Power Required: 100 to 125 or 200 to 250 V, 50 to 400 Hz, 40 W.

Dimensions (width x height x depth): Bench: 17 x 3⅞ x 12¾ in. (435 x 99 x 325 mm); rack, 19 x 3½ x 10¾ in. (485 x 89 x 275 mm).

Weight: Net, 14 lb (6.5 kg); shipping. 21 lb (10 kg).

Catalog Number	Description
1383-9700	Bench Model
1383-9701	Rack Model

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WARRANTY

We warrant that this product is free from defects in material and workmanship and, when properly used, will perform in accordance with applicable GenRad specifications. If within one year after original shipment it is found not to meet this standard, it will be repaired or, at the option of GenRad, replaced at no charge when returned to a GenRad service facility. Changes in the product not approved by GenRad shall void this warranty. GenRad shall not be liable for any indirect, special, or consequential damages, even if notice has been given of the possibility of such damages.

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GenRad policy is to maintain product repair capability for a period of ten years after original shipment and to make this capability available at the then prevailing schedule of charges.

Introduction—Section 1

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1.1 PURPOSE.

The Type 1383 Random-Noise Generator (Figure 1-1) provides a high level of electrical noise at its output terminals. This type of signal is useful in testing video- and radio-frequency systems for operation in the presence of noise, and for measurement of the noise figure of such systems. The noise signal can be used directly, or it can be used to modulate the output of a signal generator. It is useful in making crosstalk measurements and in determining the effective bandwidth of filters. The 20-Hz to 20-MHz bandwidth of the noise makes it useful for even wide-band video systems.

1.2 DESCRIPTION.

The 1383 Random-Noise Generator consists of a thermionic diode noise source with all-semiconductor amplifiers and power supply. The noise output is useful over the frequency range from 20 Hz to 20 MHz. The noise output amplitude is indicated by a meter on the front panel, and an output attenuator permits reduction of the output by a total of 80 dB in 10-dB steps from a maximum of 1 V, rms, open circuit. The output impedance is 50Ω.

1.3 CONTROLS, CONNECTORS AND INDICATORS.

The controls, connectors and indicators on the front and rear panels of the 1383 Random-Noise Generator are listed and described in Tables 1-1 and 1-2, respectively.

The OUTPUT connector on the front panel is a GR874® coaxial connector. If desired, it may be removed from the front panel and mounted on the rear of the instrument. A snap-in hole cover (P/N 0480-2470) at the rear should be moved to the front if this change is made, to cover the hole in the front panel.

1.4 ACCESSORIES SUPPLIED.

The accessories supplied with the Generator are listed in Table 1-3.

1.5 ACCESSORIES AVAILABLE.

A Rack Adaptor Set (P/N 0480-9702) is available to convert the portable bench model for mounting in an EIA standard 19-inch relay rack. (Refer to paragraphs 2.3 and 2.4.)

Also available are various patch cords and adaptors, some of which are listed in Table 1-4.

GR874-G coaxial fixed attenuators can be used to reduce the output beyond the range of the attenuator in the instrument. Units are available with attenuation values of 3, 6, 10, 14, and 20 dB.

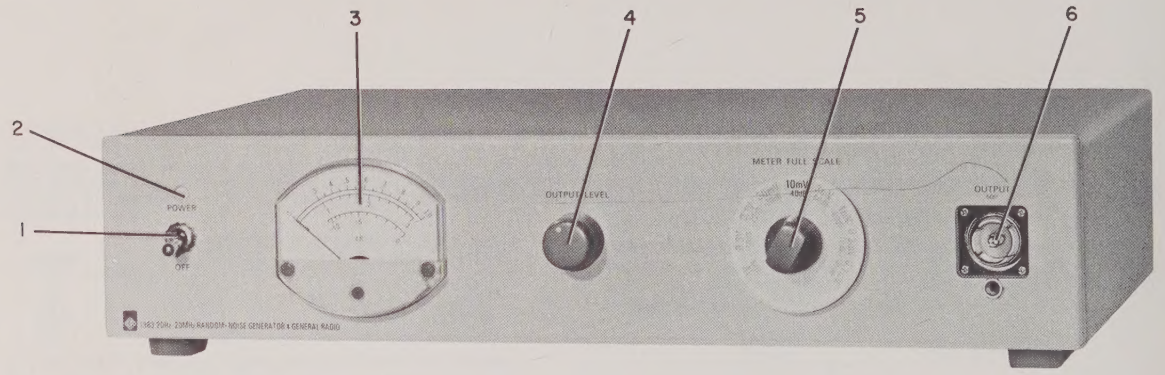

Figure 1-1. Type 1383 Random-Noise Generator.

Table 1-1

Controls, Connectors, and Indicators on the Front Panel

FIG. 1-1 REF.	NAME	TYPE	POSITIONS	FUNCTION
1	POWER	2-position toggle switch	OFF, POWER	Energizes Instrument.
2	----------	Pilot lamp	----------	Indicates when instrument is energized.
3	----------	Meter	----------	Indicates open-circuit output voltage.
4	OUTPUT LEVEL	Continuous rotary control	----------	Varies output voltage.
5	METER FULL SCALE	9-position rotary selector switch	1.0, 0.3, 0.1, 0.03, 0.01, 0.003, 0.001, 0.0003, 0.0001	Attenuates output in 10-dB steps.
6	OUTPUT 50 Ω	GR874®coaxial connector and ground jack	----------	Connection to generator output.

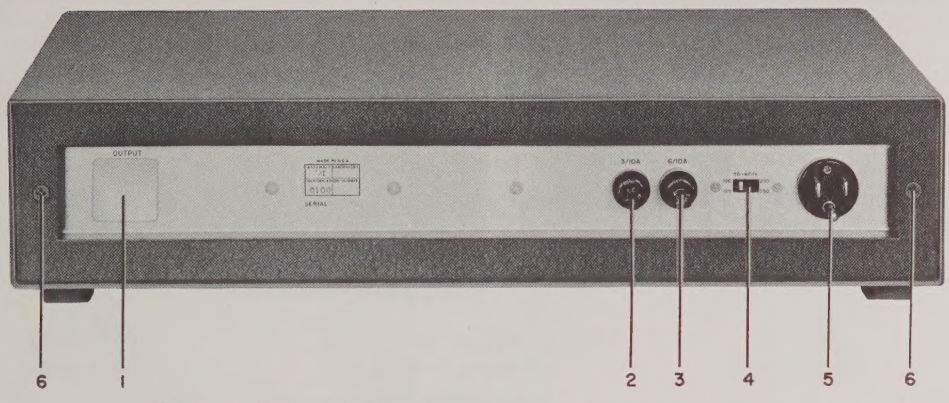

Figure 1-2. Rear panel of the Generator, showing controls and connectors.

Table 1-2

Controls and Connectors on the Rear Panel.

FIG. 1-2 REF.	NAME	TYPE	POSITIONS	FUNCTION
1	OUTPUT	(The OUTPUT connector on the front panel can be moved to this location on the rear panel.)		
2	3/10 A	Extraction-post fuse holder	----------	Holds 3/10 A fuse (Slo-Blo).
3	6/10 A	Extraction-post fuse holder	----------	Holds 6/10 A fuse (Slo-Blo).
4	----------	Screwdriver-operated slide switch	100-125, 200-250	Selects proper range of line voltage.
5	----------	3-terminal male connector (IEC)	----------	Line-power input (Accepts Belden SPH-386 conn.)

Table 1-3

Accessories Supplied.
(Refer also to Parts List.)

QUANTITY	ITEM	GR PART NO.
1	Power Cable, 7-foot, 3-wire	4200-9625
2	Spare Pilot Lamps	5600-0300 (GE No. 328)

Table 1-4

Some of the many coaxial patch cords,adaptors, and other accessories available for use with the Generator (cables are approximately three feet long.)

GR PART NUMBER	DESCRIPTION	GR CATALOG NUMBER
Cables		
874-R22A	GR874 to GR874	0874-9682
874-R22LA	GR874 to GR874, locking connectors	0874-9683
1560-P95	Phone plug to double banana plug	1560-9695
776-B	GR874 to BNC (plug)	0776-9702
Adaptors, non-locking		
874-QBJA	GR874 to BNC (jack)	0874-9700
874-QBPA	GR874 to BNC (plug)	0874-9800
874-QUJ	GR874 to UHF (jack)	0874-9718
Adaptors, locking		
874-QBJL	GR874 to BNC (jack)	0874-9701
874-QBPAL	GR874 to BNC (plug)	0874-9801
874-QUJL	GR874 to UHF (jack)	0874-9719
874-Q2	GR874 to binding posts	0874-9870
Fixed Attenuators, non-locking		
874-G3	3 dB	0874-9564
874-G6	6 dB	0874-9568
874-G10	10 dB	0874-9570
874-G14	14 dB	0874-9560
874-G20	20 dB	0874-9572
Fixed attenuators, locking		
874-G3L	3 dB	0874-9565
874-G6L	6 dB	0874-9569
874-G10L	10 dB	0874-9571
874-G14L	14 dB	0874-9561
874-G20L	20 dB	0874-9573
Miscellaneous, non-locking		
874-W50B	Termination, 50 Ω	0874-9954
874-T	Tee	0874-9910
874-X	Insertion Unit	0874-9990
874-TPD	Power Divider	0874-9912
Miscellaneous, locking		
874-W50BL	Termination, 50 Ω	0874-9955
874-TL	Tee	0874-9911
874-TPDL	Power Divider	0874-9913

Installation—Section 2

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2.3 RELAY-RACK MOUNTING 2-2
2.4 MOVING THE OUTPUT CONNECTOR 2-2
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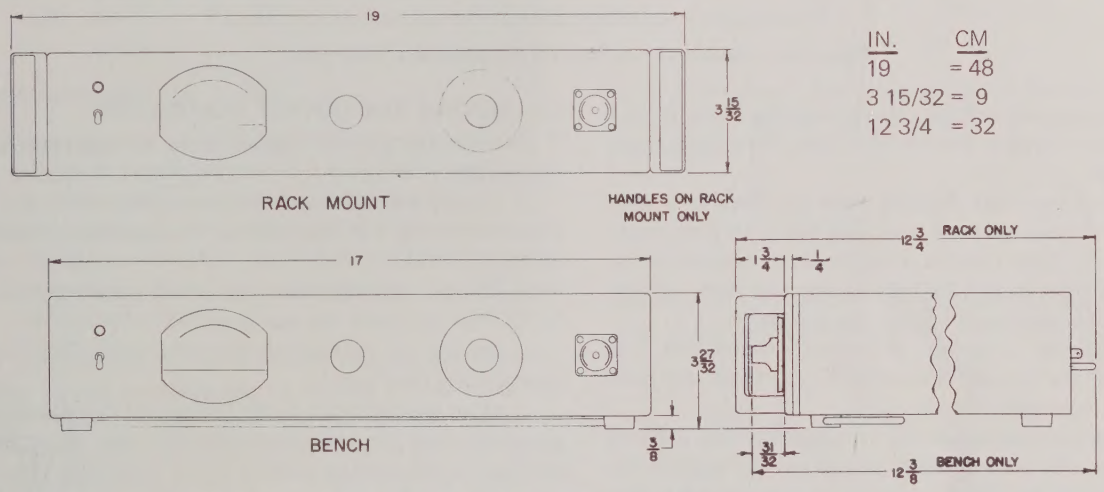
2.1 DIMENSIONS.

The dimensions of the 1383 are shown in Figure 2-1.



IN.	CM
19	= 48
3 15/32	= 9
12 3/4	= 32

Figure 2-1. Dimensions of the Generator in inches.

2.2 BENCH MODEL.

The 1383-9700 (bench model) Random-Noise Generator is delivered completely assembled in a metal cabinet, ready for bench use. A convenient bail, located between the front feet, can be pulled down to raise the front of the instrument and provide a better view of the control settings.

To convert the bench model for relay-rack use, proceed as follows (see Figure 2-2):

a. Order an 0480-9702 Rack Adaptor Set. Table 2-1 lists the parts included in the Set.

b. Loosen the two captive 10/32 screws (5, Figure 1-2) in the rear of the cabinet until the instrument is free; slide the instrument forward, out of the cabinet.

c. Remove the four rubber feet from the cabinet. Simply push out the two rear feet. Spread the bail (A, Figure 2-2) slightly, and the two front feet (B) and the bail will drop out. Be sure to save all parts as they are removed for possible reconversion of the instrument to bench mounting.

d. Pierce and push out the plugs from the four bosses

TABLE 2-1

PARTS INCLUDED IN RACK ADAPTOR SET
P/N 0480-9702

Fig. 2-2 Ref	No. Used	Item	GR Part No.
G	2	Rack-Adaptor Assemblies (handles)	0480-4902
	1	Hardware Set includes	0480-3080
D		8 Screws, BH 10-32, 5/16" (only 4 required)	
E		4 Screws, BH 10-32, 9/16" with nylon cup washers	

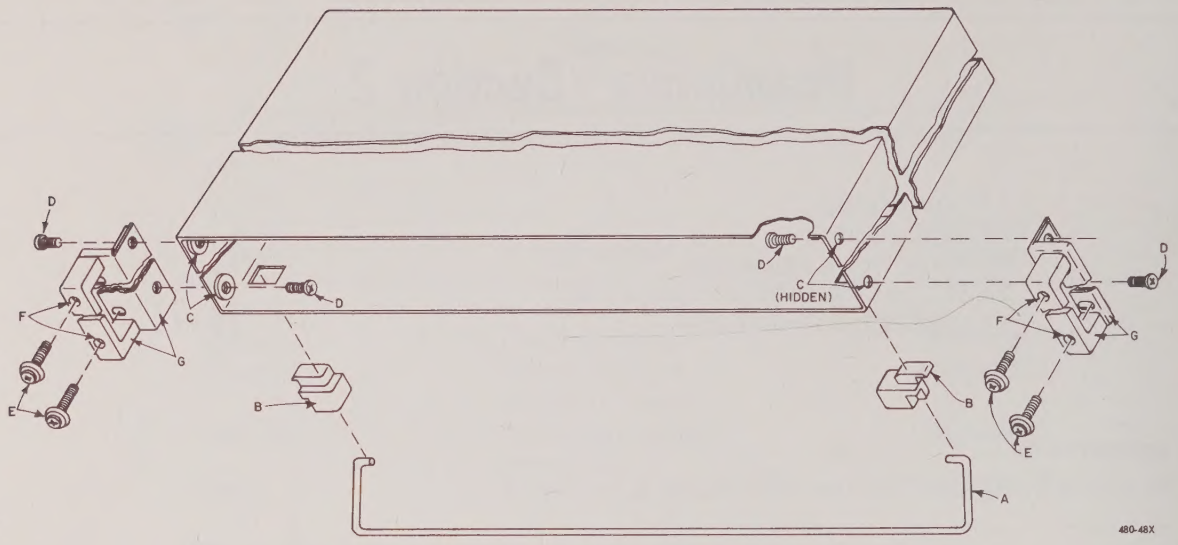


Figure 2-2. Method of mounting the Generator in a relay rack.

(C) on the inner sides of the cabinet, near the front. Do not damage the threads in the threaded holes. Push from inside the cabinet.

e. Attach one Rack Adaptor Assembly (handle) to each side of the cabinet, as shown, using two 5/16-inch screws (D) in each. Note that the screws enter in opposite directions, one from inside the cabinet and one from outside. Use the upper and lower holes in the assemblies.

f. Install the instrument in the cabinet and lock it in place with the two captive screws through the rear panel that were loosened in step b.

g. Slide the entire assembly into the relay rack and lock it in place with the four 9/16-inch screws (E) with captive nylon cup washers. Use two screws on each side and tighten them by inserting a screwdriver through the holes (F) in the handles.

To reconvert the instrument for bench use, reverse the above procedure.

2.3 RELAY-RACK MOUNTING.

The 1383-9701 (rack-mounted) Random-Noise Generator is delivered completely assembled in a metal cabinet ready for mounting in an EIA standard 19-inch relay rack. (If desired, the OUTPUT connector on the front panel of the relay-rack model can be moved to the rear panel. Refer to paragraph 2.4).

To install the rack model in a relay rack, slide the instrument (in its cabinet) into the rack and lock it in place with the four 9/16-inch screws (E, Figure 2-2) with captive nylon cup washers. Use two screws on each side and tighten them by inserting a screwdriver through the holes (F) in the handles.

To convert the rack model to a bench model, remove the rack-adaptor set by reversing the procedure of paragraph 2.2.

2.4 MOVING THE OUTPUT CONNECTOR.

To move the OUTPUT connector to the rear panel (see Figure 8-2):

a. Loosen the two captive screws at the rear of the instrument (6, Fig. 1-2), and remove the instrument from its cabinet.

b. Remove and save the gray cover plate (P/N 0480-2470) from its hole in the rear panel.

c. Remove the four screws that hold the OUTPUT connector in the front panel.

d. Move the connector to the rear panel. Pull the rubber grommets from the keyhole-shaped slots they are in, slide them along the cable as necessary, and press them into the other slots so that the cable easily reaches the rear panel (see Figure 8-2).

e. Use the four screws to fasten the connector into the rear panel. (The wider pair of outer-conductor contacts are usually aligned vertically.)

f. Press the snap plug removed in step b into the hole in the front panel to serve as a cover.

g. Place the instrument back in its cabinet, and tighten the two screws at the rear of the instrument.

h. To replace the connector in the front panel, reverse the above procedure.

2.5 CONNECTING THE POWER.

The wiring of the power transformer can be switched, by means of the 2-position slide switch (4, Figure 1-2) on the rear panel, to accept 50- to 400-Hz line power of either 100-125 V or 200-250 V.

Connect the three-wire power cable to the line and to the 3-terminal male connector (5, Figure 1-2) on the rear panel. One 0.3-A fuse and one 0.6-A fuse are used for either line voltage. Power consumption is approximately 35 W.

Properties of Random Noise – Section 3

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3.1 DEFINITIONS.

The acoustical term "noise" was applied originally to certain electrical signals because of the undesirable audible effects they produced at the output of radio receivers. Noise, in the electrical sense, is now a broad term that means any unwanted signal, and therefore can include not only input-stage noise and atmospheric noise in radio receivers, but also crosstalk, hum, and distortion.

Random noise is a signal whose exact value at any future moment cannot be predicted. It is even a little more than that; it means a signal containing no periodic component whose future value can be predicted. Unlike periodic signals, whose spectra consist of one or more discrete lines corresponding to the various frequency components, random noise has a spectrum that is a continuous function of frequency, containing no discrete line components.

3.2 DESCRIPTION OF RANDOM NOISE.

It is only possible to describe random noise in terms of its average properties that cannot be measured instantaneously but must be averaged over some finite measurement time. The two most important characteristics of random noise are its amplitude distribution and its spectrum.

3.3 AMPLITUDE DISTRIBUTION.

3.3.1 Amplitude Distribution Functions.

The instantaneous value of a random noise, at some particular instant, cannot be predicted, but for many noises we can speak of the probability that the voltage will lie in some particular range. This probability is given by a function called the amplitude density distribution, p(v). When multiplied by a voltage increment, dv, this function gives the probability that, at any given instant, the voltage lies between v and v + dv. Because the voltage must exist at some value, it follows that the integral

$$\int_{-\infty}^{\infty} p(v)dv = 1.$$

Another useful probability function is the integral over part of that range, called the amplitude distribution, P(v), defined as

$$P(v) = \int_{-\infty}^{v} p(x)dx.$$

Thus defined, P(v) is the probability that the voltage, at any given instant, lies below the value v. The values of these probability functions lie on a scale between 0 and 1, with 1 denoting certainty. A probability of 0.5 denotes a 50% chance of occurance.

3.3.2 The Gaussian Distribution.

The Gaussian or normal distribution is particularly important for several reasons: It describes the "normal" occurrance of random measurement errors in experiments. The amplitude of thermal noise in a resistance and shot noise in a vacuum tube are Gaussianly distributed. The distribution of the sum of many independent time-varying voltages approaches the Gaussian distribution in the limit as the number of such voltages is increased, regardless of the distribution of the individual voltages (derived from the Central Limit Theorem of statistics). An extension of this reasoning leads to the result that filtering that reduces the bandwidth generally makes a non-Gaussian noise more Gaussian, so that, in this sense, the Gaussian is a stable distribution. For these reasons, the Gaussi-

an distribution is of fundamental importance and is the most appropriate distribution of random noise in most experiments. For the Gaussian distribution,

$$p(v) = \left(\frac{1}{\sigma\sqrt{2\pi}}\right) e^{-\frac{v^2}{2\sigma^2}}$$

and

$$P(v) = \frac{1}{2}\left[1 + \text{erf}\left(\frac{v}{\sigma\sqrt{2}}\right)\right]$$

where σ is the root-mean-square voltage (in statistics, the standard deviation), and erf denotes the error function. Values of these functions are given in Table 3-1 and the functions are graphed in Figures 3-1 and 3-2.

TABLE 3-1
Gaussian amplitude distribution functions.

v	p(v)	P(v)
-5σ	$.000\ 001\ 487/\sigma$	.000 000 287
-4σ	$.000\ 133\ 8/\sigma$	.000 031 67
-3σ	$.004\ 432/\sigma$	.001 350
-2σ	$.053\ 99/\sigma$	.022 75
-1σ	$.241\ 97/\sigma$	.158 65
0	$.398\ 94/\sigma$	.500 00
1σ	$.241\ 97/\sigma$	.841 34
2σ	$.053\ 99/\sigma$	.977 25
3σ	$.004\ 432/\sigma$	.998 650
4σ	$.000\ 133\ 8/\sigma$	.999 968 33
5σ	$.000\ 001\ 487/\sigma$	.999 999 713

It can be seen from Figure 3-2 that a Gaussianly distributed random noise lies below its positive root-mean-square value (σ = 1) 84% of the time, and therefore exceeds that value only 16% of the time.

3.3.3 Importance of Knowing the Distribution.

Knowledge of the amplitude distribution of a noise is important in measuring its magnitude. Electronic voltmeters respond to different measures of the amplitude of the voltage, such as the rms, the peak, or the (full-wave-rectified) average. The peak and average values of various waveforms having 1-volt, rms, amplitude are given in Table 3-2. A voltmeter responding to the average and calibrated to indicate the rms value of a sine wave will, when measuring Gaussian noise, indicate a value that is low by the factor 0.798/0.900 = 0.887 (-1.05 dB)[1]. Voltmeters that respond to the true rms value are quite appropriate for the measurement of noise, because they can indicate the rms value without correction, regardless of the amplitude distribution.

TABLE 3-2
Rms, peak, and full-wave rectified average voltage values of various waveforms.

	RMS	PEAK	FULL-WAVE RECTIFIED AVERAGE
Sine Wave	1.0	1.414 ($\sqrt{2}$)	0.900 $\left(\frac{2\sqrt{2}}{\pi}\right)$
Square Wave	1.0	1.0	1.0
Gaussian Noise	1.0	∞	0.798 $\left(\sqrt{\frac{2}{\pi}}\right)$

The response of a peak-indicating voltmeter is dependent upon the charging and discharging time constants of its rectifier circuits; when random noise is measured, each type of peak-responding voltmeter may indicate a different value. The response time of a rectified-average-responding voltmeter is, in practice, often shorter than that of a true rms voltmeter, and it can be used with the correction factor cited above. However, for measurements without the correction factor, or for meas-

[1] This and much other information concerning random noise is contained in a General Radio publication, "Useful Formulas, Tables and Curves for Random Noise", Instrument Note 1N-103 (June, 1963). A copy of this six-page compedium can be obtained free of charge by writing to General Radio, West Concord, Mass., 01781.

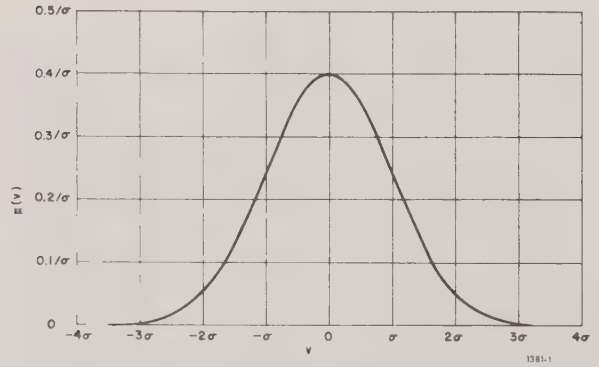

Figure 3-1. The Gaussian probability density function of σ, the root-mean-square amplitude.

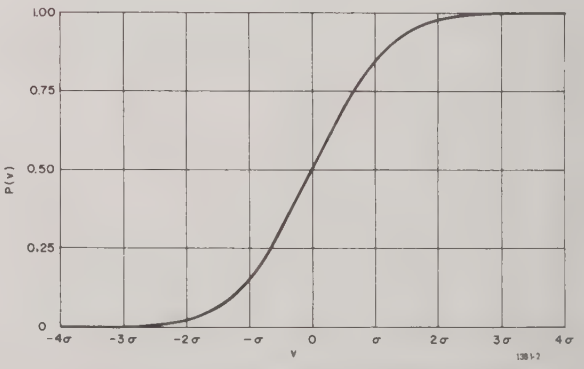

Figure 3-2. The Gaussian probability distribution function plotted as a function of σ, the root-mean-square amplitude.

urements on non-Gaussian noise, it is necessary to use a true-rms instrument.

3.3.4 Measuring Amplitude Distribution.

The amplitude distribution, P(v), can be measured by means of a circuit that measures the percentage of time during which the noise voltage exceeds (or does not exceed) the voltage level, v. Apparatus for this purpose generally includes some form of level-crossing detector and, for high-speed operation, Schmitt-circuit wave-shapers. The measurement must be made by averaging over a time long enough to smooth the fluctuations in the indication to negligible size.

The amplitude density distribution, p(v), can be measured by similar, but somewhat more complicated, apparatus that indicates the percentage of time that the noise voltage exists within the range from v to (v + dv). In making any of these measurements, averaging is important, bacause only the average characteristics of the noise can be measured meaningfully.

In the present state of the art, level-crossing detector circuits cannot be made to operate fast enough for measurements on random noise containing such high frequencies as those produced by the 1383. However, measurements can be made by sampling the noise at a lower-frequency rate, such as 50 or 100 kHz. If the sampling efficiency is unity, the sampled-and-held waveform has the same amplitude distribution as the high-frequency random noise, but it contains much lower frequency components, and it can be applied successfully to the level-crossing detector circuits mentioned above.

3.3.5 Amplitude Distribution of the Type 1383.

The noise source used in the 1383 is a thermionic diode. The noise is generated as shot noise in the plate current of the diode, the amplitude distribution of which is definitely Gaussian, because the total current is the sum of a very large number of independent pulses.[2] The amplifiers in the 1383 have been specially designed so that, at full output amplitude, pulses below 3σ will not be clipped.

3.4 SPECTRUM.

3.4.1 General.

The spectrum of a random signal is different from that of a periodic signal, which is composed of one or more discrete lines, each of which corresponds to a frequency component of the periodic signal. A truly random signal contains no periodic frequency components, and has a spectrum that is a continuous function of frequency.

3.4.2 Spectrum Functions.

The frequency content of a random noise is described by a function called the spectral intensity, which has the dimensions of voltage squared per unit bandwidth. (When divided by a value of resistance, it is equal to the power that voltage would dissipate in that resistance, per unit bandwidth). The spectral intensity is the Fourier transform of the autocorrelation function, and is the spectrum function most often used in mathematical analysis of random noise. It is not the most convenient function for practical use, however, because spectra are usually measured as voltage, rather than voltage squared, in a given bandwidth, and filter responses, used in shaping noise spectra, are usually measured as voltage functions. Therefore, for practical use, we define the voltage spectrum as numerically equal to the square root of the spectral intensity. It has units of voltage per square root of bandwidth, but may be spoken of as voltage in a given bandwidth. Spectra shown in Figure 3-3 are plotted as voltage spectra.

3.4.3 White Noise.

Noise whose spectral intensity is constant over a range of frequencies is called white noise, by analogy with white light, which contains more or less equal intensities of all visible colors.[3] White noise cannot contain equal amplitudes at all frequencies, for then the total power in the noise would be infinite. White noise, therefore, means that the spectrum is flat over the range of interest, for example, throughout the audio-frequency range. Because of its flat spectrum, white noise is particularly convenient as a starting point for many experiments.

3.4.4 Importance of Knowing the Spectrum.

In most experiments involving random noise, knowledge of the spectrum of the noise being used is vitally necessary. When noise is used as a driving-point signal to determine the response of some system, the response is meaningful only when the input spectrum is known, and is usually most conveniently studied when the input spectrum is flat. There are, of course, cases where other spectra are more convenient. If, in such cases, a filter can be constructed whose response has the shape of the desired spectrum, white noise is the proper input for that filter to produce the desired spectrum at its output.

3.4.5 Noise-Spectra Measurements.

The spectrum of a noise can be measured with any wave analyzer whose frequency range is appropriate. For the output indication to be free of fluctuations that might cause reading errors, the product of analysis bandwidth and the averaging time must be large. As in the measurement of the amplitude distribution, the spectrum can only be measured accurately by averaging over a relatively long time interval.

Wave analyzers generally indicate the voltage in the analysis passband. The indication is therefore proportional to w(f), not W(f). It is convenient to reduce all measurements to a

[2] Bennett, W.R., "Electrical Noise", McGraw-Hill Book Co., New York (1960), p.40.

[3] Although, as Bennett (op.cit., p. 14) points out, the analogy has been drawn incorrectly, because spectroscopists were measuring intensity as a function of wavelength, and found it to be substantially constant per unit wavelength, not per unit frequency.

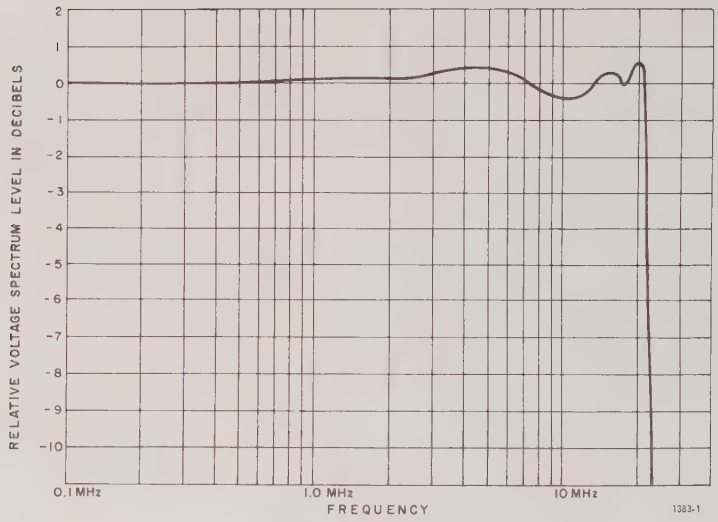

Figure 3-3. Typical voltage spectrum of the 1383 Random-Noise Generator.

common bandwidth basis, and the most-often-used bandwidth is one cycle. Units for W(f) are "volts squared per cycle bandwidth," and considerable use has been made of the unit "volts per root-cycle" for w(f). Now that "cycles" have become "hertz," this term is even more cumbersome, and is perhaps best replaced by "volts in a 1-hertz band."

In order to convert to volts in a 1-hertz band, it is necessary to divide the voltage indication of the analyzer by the square root of the analysis bandwidth. For example, using the General Radio Type 1900 Wave Analyzer, multiply by the factors given in Table 3-3 to convert measured values of random noise to volts in a 1-hertz band.

TABLE 3-3
Correction factors for converting voltage indication of the Type 1900 Wave Analyzer to voltage in a 1-hertz band.

ANALYZER BANDWIDTH	CORRECTION FACTOR[4]
3 Hz	0.650 (-3.7 dB)
10 Hz	0.357 (-9.0 dB)
50 Hz	0.159 (-15.9 dB)

[4]These numbers include the correction for the average-responding voltmeter in the 1900 Wave Analyzer.

In a constant-percentage-bandwidth analyzer, the analysis bandwidth is directly proportional to the center frequency of the pass band. This necessitates dividing the voltage indication by the square root of the frequency as well as by the correction factor for the fractional bandwidth itself. When using constant-percentage-bandwidth analyzers, such as the General Radio Type 1564 Sound and Vibration Analyzer or the Type 1558 Octave-Band Analyzer, multiply the analyzer voltage indication by the appropriate conversion factor in Table 3-4.

TABLE 3-4
Correction factors for converting voltage indication of a constant-percentage-bandwidth analyzer to voltage in a 1-hertz band.

BANDWIDTH	CORRECTION FACTOR
1/10 Octave	$3.80/\sqrt{f}$
1/3 Octave	$2.08/\sqrt{f}$
1 Octave	$1.19/\sqrt{f}$

3.4.6 Spectrum of the Type 1383.

The noise produced by the Type 1383 is white over a wide range of frequencies; the voltage spectrum is flat within ±1 dB for frequencies from 20 Hz to 10 MHz, and within ±1.5 dB for frequencies from 10 to 20 MHz. A typical spectrum is shown in Figure 3-3. The spectrum is cut off very sharply at 20 MHz, so that the effective bandwidth of the noise is quite closely 20 MHz. At the open-circuit output amplitude of 1 V, the voltage spectrum level is 224 μV in a 1-Hz bandwidth.

3.5 STATIONARITY.

A random noise is said to be stationary[5] if its various statistical parameters, such as the amplitude distribution and the spectral intensity, do not change with time. Random noise, of course, never repeats the same pattern from one moment to the next, but, if it is stationary, many measurements of the spectrum made at different times will all indicate the same result, except for the unavoidable errors of measuring a random quantity in a finite time. In discussing tests for stationarity, Bendat and Piersol[6] point out that, for most noise-generating

[5]Bennett, op. cit., p. 52-54.

[6]Bendat, J.S., and Piersol, A.G., *Measurement and Analysis of Random Data*, John Wiley and Sons, Inc., New York, 1966, pp. 219-223.

processes, it is sufficient to determine that the mean and the variance (square of the standard deviation, σ) do not change with the time at which they are measured. Because the output of the 1383 is ac coupled, the mean is automatically zero, and it is only necessary to observe the rms amplitude to prove stationarity. This can be done by seeing that the fluctuations in long-time recordings of the amplitude of the noise are no greater than the value predicted from the bandwidth of the noise and the smoothing time of the detector.

The importance of stationarity in a random-noise generator is analogous to stability in an oscillator; the user is assured that there is no change in the spectrum or the amplitude distribution during the course of an experiment. The stationarity of the noise output of the 1383 comes, first of all, from its noise source; the temperature-limited thermionic diode has long been recognized and used as a standard noise source for noise-figure measurements of high-frequency amplifiers.[7] The noise current it produces is proportional to the square root of the dc plate current, which, in the 1383, is held constant by feedback controlling the filament current. The gain of the noise-current amplifiers is stabilized by feedback.

[7]Spangenberg, K.R., *Vacuum Tubes*, McGraw-Hill Book Co., Inc. New York, 1948, p. 307.

3.6 SUMMARY.

Because various terms used in speaking of random noise are sometimes confused, a summary is presented here of the most-often-used words, together with a brief explanation of their meaning: "Noise" is any unwanted signal. "Random noise" is a signal whose future value cannot be exactly predicted and that does not contain any periodic components. To differentiate clearly between the spectrum and the amplitude distribution, in this book the word "density" is used only in connection with the amplitude distribution. The word "intensity" is used only in connection with the spectrum. "Gaussian" applies only to the amplitude distribution and refers to a particular theoretical distribution. "White" refers only to the spectrum, and means that the spectral intensity is constant over some range of interest.

Principles of Operation—Section 4

4.1 DESCRIPTION OF CIRCUIT 4-1

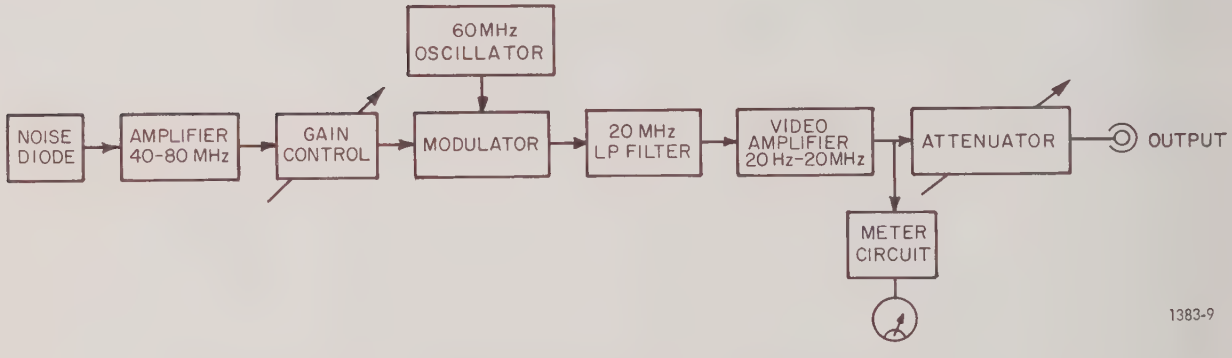

Figure 4-1. Block diagram of the 1383 Random-Noise Generator.

4.1 DESCRIPTION OF CIRCUIT.

Figure 4-1 is a block diagram of the Type 1383 Random-Noise Generator. The noise source is a thermonic diode operated in the temperature-limited mode. The noise output of such a diode operated in this way is exactly Gaussian, it is spectrally flat to extremely high frequencies, and its level is proportional to the square root of the dc plate current. To keep the amplitude stable, the filament current of the noise diode is controlled by feedback, to maintain a constant current. The noise output of the diode is amplified in the frequency range from 40 to 80 MHz. By heterodyning against a 60-MHz local oscillator, the noise frequency is translated to the 0-to-20-MHz band. A sharp-cutoff low-pass filter ensures that higher noise frequencies and residual local-oscillator signals are removed. An ac-coupled amplifier is used to increase the power of that noise to the output level of 1 V. The voltmeter (which indicates the output level) and the output attenuator complete the circuit. All power supplies are regulated except the plate supply to the noise diode.

Operating Procedure—Section 5

5.1 GENERAL 5-1
5.2 OUTPUT LEVEL CONTROL 5-1
5.3 METER FULL SCALE CONTROL 5-1
5.4 OUTPUT CONNECTIONS 5-1
5.5 OUTPUT IMPEDANCE 5-1
5.6 MODIFYING THE OUTPUT 5-1

5.1 GENERAL.

With the instrument in position on the bench or installed in a relay rack, set the screwdriver-operated slide switch S502 (4, Figure 1-2) to the range corresponding to the power-line voltage. Connect the instrument to the line power, using the power cable supplied (P/N 4200-9622), and turn on the POWER switch.

Follow the instructions given in paragraphs 5.2 and 5.3 for setting the OUTPUT LEVEL and METER FULL SCALE controls.

5.2 OUTPUT LEVEL CONTROL.

The OUTPUT LEVEL control is a continuous rotary control by means of which the output level can be set at any selected value between its maximum open-circuit value and zero. The open-circuit output voltage is indicated by the meter on the front panel, which must be read on the scale appropriate to the setting of the output attenuator (the METER FULL SCALE control).

5.3 METER FULL SCALE CONTROL.

The METER FULL SCALE control is the output attenuator and permits reduction of the output-voltage level by 80 dB from its maximum, in 10-dB steps. The voltage indicated is the open-circuit output voltage; when the output is loaded by 50 Ω, the output voltage is reduced by half. Decibel readings on the dial of the METER FULL SCALE control can be added to the decibel indication of the meter to obtain the open-circuit output voltage in decibels below 1 V.

5.4 OUTPUT CONNECTIONS.

The output connector on the front panel is a GR874, locking-type, coaxial connector. Generally, the output should be taken by means of a mating GR874 connector into a closed coaxial system. Adaptors to other types of high-frequency connectors are available (refer to Table 1-4). The output connector can be moved to the rear panel if more convenient, as when the instrument is mounted in a relay rack (refer to paragraph 2.4 and Figure 8-2).

5.5 OUTPUT IMPEDANCE.

The output impedance of the 1383 is 50 ohms, ±2%. The output can be short circuited without causing distortion of the output current. The maximum output current into a short circuit is 20 mA, rms, with occasional peaks that may exceed four times that value.

5.6 MODIFYING THE OUTPUT.

5.6.1 Producing Lower Levels.

GR874-G fixed coaxial attenuators (refer to Table 1-4) in reducing the output level beyond the range of the 1383 output attenuator (the METER FULL SCALE control). These units are available with attenuations of 3, 6, 10, 14, and 20 dB. They are designed for insertion in a 50-ohm line.

5.6.2 Generating Bands of Noise.

It may be necessary to restrict the bandwidth of the noise output of the 1383. For inserting a tuned circuit or filter in series with the 50-ohm output, it may be convenient to use the GR874-X insertion unit, which permits totally-shielded connection of any circuit that will fit in its 2-inch long, 9/16-inch-diameter space.

5.6.3 Generating Higher Levels.

The noise generated by the 1383 Random-Noise Generator can be amplified by any amplifier whose frequency range is adequate. The high crest factor of Gaussian noise must be kept

in mind in choosing the power rating of the amplifier so that the noise will not be clipped. In order that peaks of 3σ be passed without clipping, the amplifier must be capable of amplifying a sine wave without distortion to a power level 4.5 times greater than the average noise power desired.

5.6.4 Generating Noise at Higher Frequencies.

Noise at higher frequencies can be generated by using a double-balanced mixer to modulate a high-frequency carrier from an oscillator or signal generator. The result will be a band of noise 40 MHz wide, centered on the carrier frequency. (There will be a notch 40 Hz wide at the carrier frequency.[1]) The degree of discrimination against the carrier and the upper carrier frequency that can be used will depend upon the characteristics of the mixer used. Many such mixer units are commercially available.[2]

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[1] Perhaps wider, depending upon the characteristics of the mixer.

[2] Relcom, E. G., Mountain View, Cal.

Applications – Section 6

6.1 GENERAL 6-1
6.2 SIMULATION OF BACKGROUND NOISE 6-1
6.3 MEASURING INTERMODULATION DISTORTION. 6-1
6.4 MEASURING CROSSTALK 6-1
6.5 MEASUREMENT OF EFFECTIVE BANDWIDTH 6-1
6.6 NOISE TEMPERATURE 6-2
6.7 NOISE FACTOR OR NOISE FIGURE 6-3

6.1 GENERAL.

The Type 1383 Random-Noise Generator is useful wherever a broad-band, high-level source of white noise is needed. Its 50-ohm output impedance and spectral intensity that is substantially constant to 20 MHz make it particularly useful at radio frequencies.

For audio-frequency applications, Types 1381 and 1382 Random-Noise Generators[1] may be found to be more useful. They are intended for applications in the fields of acoustics, electroacoustics, psychoacoustics, and vibration analysis, in addition to their general use as **audio-frequency** generators of random electrical noise.

6.2 SIMULATION OF BACKGROUND NOISE.

In studying the performance of radio, telemetry, radar or sonar systems with regard to their ability to transmit, detect, and recover signals in noise, it is convenient to simulate the real mixture of signal and naturally occurring noise by adding noise of controlled characteristics to a standard signal. Noise sometimes becomes the signal itself in tests of correlation receivers and other modern signal-processing systems.

A mixture of signal and noise can be created by adding the output of a signal generator (possibly modulated in some appropriate manner) to the noise from the 1383. This can be accomplished with the GR874-TPD or GR874-TPDL Power Divider (see Table 1-4), with which signals in two 50-ohm systems can be added together. Noise that has been heterodyned to higher frequencies (see paragraph 5.6.4) can be used for this purpose.

6.3 MEASURING INTERMODULATION DISTORTION.

Random noise is used in one very effective method of measuring intermodulation distortion.[2] White noise, which has been passed through a band-stop filter that reduces the level of the noise by, say, 80 dB over a narrow range of frequencies, is applied to the input of a system. Spectrum measurements of the system output indicate how much the "notch" in the noise spectrum has been filled in by intermodulation products. This is an especially significant measurement because white noise contains all the frequencies to which the system responds, and represents, in this sense, a "worst-case" type of test signal.

6.4 MEASURING CROSSTALK.

White noise is a very appropriate signal for use in measuring crosstalk in multichannel telephone, radio, or telemetry systems. Spectrum analysis of the crosstalk signal identifies the frequencies that cause the greatest disturbance, thereby providing some assistance in determining the cause and specifying a cure.

6.5 MEASUREMENT OF EFFECTIVE BANDWIDTH.

When wave analyzers or filters (or more complex systems) are used to measure the spectral density of noise, it is necessary to know the effective bandwidth of the filter or of the system. The effective noise bandwidth can be thought of in terms of an ideal filter having a rectangular frequency characteristic (constant over a range of frequencies, and zero everywhere else). The effective noise bandwidth of a filter is the width of the pass band of the ideal filter whose output is exactly equal to the output of the actual filter when the inputs are the same white noise, provided the maximum transmissions of the two filters are the same. It can be measured by finding the total signal transmitted when white noise of known spectral level is applied to the input. The frequency range of the white noise must include all frequencies for which the filter being measured has appreciable transmission.

When the effective bandwidth of the input noise is known, the necessary computations are simplified. Then the

[1] Faran, J.J., Jr., "Random-Noise Generators", General Radio *Experimenter* Vol. 42, No. 1, pp. 3-13 (January, 1968).
[2] MIL STD-188B.

effective bandwidth of the filter is

$$EBW_f = EBW_n \left(\frac{N_{out}}{N_{in} G_{fmax}} \right)^2$$

where EBW_n is the effective bandwidth of the noise;

N_{out} is the output noise voltage:

N_{in} is the input noise voltage;

G_{fmax} is the maximum or peak gain of the filter (as measured with a sine-wave signal).

The effective bandwidth of the noise output of the 1383 is very close to 20 MHz. In measuring the output voltage, it should be kept in mind that the voltmeter used should respond accurately to frequencies as high as 20 MHz and its operation (average, peak, or rms) should be known (refer to paragraph 3.3.3). The voltmeter should not be connected at the end of an unterminated cable, but should either terminate the cable (if a 50-ohm input adaptor is available) or should be bridged onto a terminated cable.

6.6 NOISE TEMPERATURE.

6.6.1 Definition.

It is sometimes convenient to express the noise level in a circuit in terms of **noise temperature**. The noise voltage across a resistance due to thermal agitation of the free electrons in it (thermal noise) is

$$e_n = \sqrt{4kTRB} \quad ,$$

where e_n is the rms noise voltage,
k is Boltzmann's constant (1.38×10^{-23} joules/°K),
T is the absolute temperature of the resistance in °K,
R is the resistance in ohms,
and B is the bandwidth in hertz in which the noise is being observed.

When an artificially-generated noise voltage, e_a, is impressed across a resistance, it adds to the thermal noise whose amplitude is given above. It is then possible to define **noise temperature** as that temperature at which the thermal noise power would equal the total noise power[3]:

$$T_n = \frac{e_n^2 + e_a^2}{4RB} \quad . \qquad (6\text{-}1)$$

Because noise temperature depends upon the square of the noise voltage, such values can become extraordinarily large; for example, the noise temperature of the output of the 1383 at full output is 1.8×10^{13} °K. Noise temperature is most useful in describing the equivalent input noise of high-frequency receivers and amplifiers, where, incidentally, for certain types of circuits, the equivalent input noise temperature (see below) is considerably lower than the ambient temperature.

The noise temperature of the output of the 1383 can never be less than its actual temperature, because its output circuits are comprised of real resistances. Figure 6-1 shows how the noise temperature of the output varies with the amount of attenuation when the OUTPUT LEVEL control is set so that the meter indicates full scale. Attenuation up to 80 dB is available with the METER FULL SCALE control; additional attenuation must be obtained with external attenuators such as GR 874-G units (refer to paragraph 5.6.1). As is readily apparent, the noise temperature levels off at 290°K (23°C) as the attenuation is increased (assuming the noise generator and attenuators are at 23°C).

6.6.2 Measurement of Effective Input Noise Temperature.

The **effective input noise temperature** of a receiver or amplifier is the temperature at which the resistive component of the input source would generate an amount of noise exactly equal to that arising in the receiver or amplifier only. One procedure for measuring the effective input noise temperature involves knowledge of the effective noise temperature of a source under both hot (**on**) and cold (**off**) conditions.[4] For amplifiers intended for operation from a 50-ohm source, the effective noise temperature of the output of the 1383 when **on** can be read from Figure 6-1 or calculated from equation 6-1, paragraph 6.6.1. The effective noise temperature when the noise generator is **off** is the temperature of the noise generator (and its output attenuators). Normal room temperature (290°K) is often a close-enough approximation.

The measurement is made by connecting a noise generator to the receiver and measuring the output power when the noise generator is cold **off** and hot **on**. The effective input noise temperature is then

$$T_{eff} = \frac{T_{ih} - (P_{oh}/P_{oc})\, T_{ic}}{(P_{oh}/P_{oc}) - 1} \quad ,$$

where T_{ih} is the noise temperature of the source when it is hot (**on**),
T_{ic} is the noise temperature of the source when it is cold (**off**),
P_{oh} is the output power when the source is hot (**on**),
and P_{oc} is the output power when the source is cold (**off**).

[3] More complicated (and more precise) definitions are given in "IRE Standards on Electron Tubes: Definitions of Terms, 1962 (62 IRE 7.S2)", *Proc. IEEE 51*, pp. 434-435 (March, 1963).

[4] For an excellent discussion of noise temperature and noise-figure measurements, refer to Mumford, W.W., and Scheibe, E.H., *Noise Performance Factors in Communication Systems*, Horizon House - Microwave, Inc., Dedham, Mass. (1968).

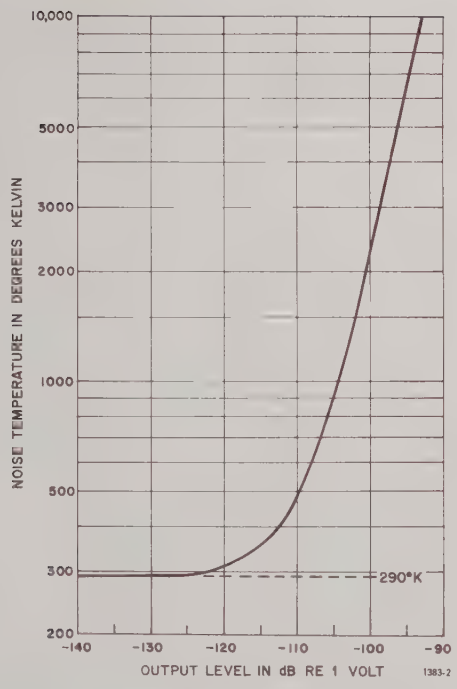

Figure 6-1. Noise temperature at the output connector of the 1383 as a function of the level in dB re 1 V, rms. Output impedance 50 Ω, temperature 23°C (290°K). Additional attenuation beyond 80 dB provided externally.

6.7 NOISE FACTOR OR NOISE FIGURE.

6.7.1 Definitions.

The **noise factor**, F, of a receiver or amplifier is the ratio of the total output noise power to that portion of the output power that is due to thermal noise in the source.[5] It is thus the amount by which the output noise is increased because of noise in the amplifier over what it would be if the thermal noise in the source was amplified by a perfect (noise-free) amplifier. In generally accepted useage, **"noise figure"** is the noise factor expressed in decibels,[6] i.e., "noise figure" is 10 log F.

6.7.2 Measurement of Noise Factor or Noise Figure.

The simplest and most convenient method of measuring the noise factor of a receiver or amplifier is usually by use of a noise generator. The measurement is similar to that used in the determination of effective input noise temperature. The noise factor is

$$F = \frac{\left(\frac{T_{ih}}{290} - 1\right) - (P_{oh}/P_{oc})\left(\frac{T_{ic}}{290} - 1\right)}{(P_{oh}/P_{oc}) - 1} ,$$

where T_{ih} is the noise temperature of the source when it is hot (on),

T_{ic} is the noise temperature of the source when it is cold(off),

P_{oh} is the power output when the source is hot (on),

and P_{oc} is the power output when the source is cold (off).

When T_{ic} is 290°K, the formula simplifies to

$$F = \frac{\frac{T_{ih}}{290} - 1}{\frac{P_{oh}}{P_{oc}} - 1} .$$

For more detailed discussion of noise factor and noise figure and the measurement thereof, the reader is referred to the literature, footnotes 4 and 5, this section.

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[5]More complicated (and more precise) definitions are given in Haus, H.A., et al, "Description of the Noise Performance of Amplifiers and Receiving Systems", *Proc. IEEE 51*, PP. 436-442 (March, 1963), Appendix.

[6]Mumford and Schlebe, op.cit., p. 69.

Service and Maintenance—Section 7

7.1 SERVICE 7-1
7.2 MINIMUM PERFORMANCE STANDARDS 7-1
7.3 RECALIBRATION 7-5
7.4 TROUBLE ANALYSIS 7-6
7.5 KNOB REMOVAL 7-7
7.6 KNOB INSTALLATION 7-7
7.7 PILOT-LAMP REMOVAL 7-7

WARNING

Line voltage terminals are exposed when covers are removed. Exercise caution during trouble-shooting, adjustments, or repair.

7.1 SERVICE.

Our warranty attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions, please write or phone our Service Department (see rear cover), giving full information of the trouble and of steps taken to remedy it. Be sure to mention the type serial and ID numbers of instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest District Office, requesting a Returned Material Tag. Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

7.2 MINIMUM PERFORMANCE STANDARDS.

7.2.1 General.

The two most important items to be measured in checking a noise generator for conformance to specifications are the spectrum and the amplitude distribution. Both of these are complicated and tedious measurements, requiring a number of pieces of equipment. Instruments have been constructed especially for this purpose at General Radio and are used in checking noise generators before they are shipped. The performance of this specially constructed equipment is not readily duplicated by commercially available instruments. However, given below are lists of equipment and instructions for checking these characteristics as well as possible, with readily available apparatus.

7.2.2 Checking the Spectrum.

General.

The spectrum of the noise output of the 1383 covers an extremely wide frequency range (20 Hz to 20 MHz). No single wave analyzer covers this range. Measurements, therefore, must be made with several analyzers that may operate in different ways, particularly with regard to bandwidth and detector characteristics. Because of the difficulties of calibrating some of them, it is recommended that the analyzers be used to check the flatness of the spectrum, rather than to make absolute determinations of the voltage spectrum level at each frequency.

Spectrum.

A list of equipment that can be used to check the flatness of the spectrum of the 1383 is given in Table 7-1. Connect the output of the 1383 to the input of either the Rhode & Schwarz Type USVH Selective Microvoltmeter (Figure 7-1) or the Hewlett Packard Model 312A Wave

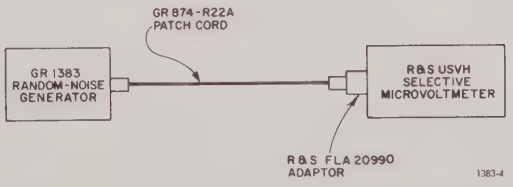


Figure 7-1. The R & S USVH Microvoltmeter can be used to check the flatness of the spectrum from 25 kHz to 20 MHz.

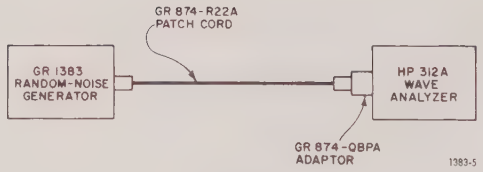


Figure 7-2. The spectrum flatness can be checked from 25 kHz to 18 MHz with the HP model 312A Wave Analyzer.

Analyzer (Figure 7-2), and set the input impedance at 50 Ω. With the full 1-V, rms, output of the 1383, the voltage delivered to the 50 Ω load of the analyzer will be 0.5 V. Set the attenuators of the wave analyzer accordingly, and tune across the range from 25 kHz to 20 MHz (necessarily stopping at 18 MHz in the case of the HP-312A). Record the meter indications as a function of frequency. This is the voltage spectrum level on an arbitrary scale.

To measure the spectrum at frequencies below 20 kHz, use the GR Type 1564 Sound and Vibration Analyzer connected as shown in Figure 7-3. The bandwidth of the noise should be reduced before it is connected to the 1564. The simple filter shown in Figure 7-4 can be constructed in a GR 874-X Insertion Unit for this purpose. This filter is designed for operation from a 50-ohm source into an open circuit (impedance high compared to 50 ohms). Place this filter at the output of the 1383 and connect it to the input of the 1564 by a shielded cable. (Use an 874-Q2 Adaptor and a 1560-P95 Adaptor Cable. See Table 1-4.) A measurement made at 25 kHz (in the 1/3-octave band) corresponds to the level measured with the high-frequency wave analyzer, and provides the transfer to a new arbitrary scale for this analyzer. The 1564 is a constant-percentage-bandwidth analyzer. Subsequent voltage

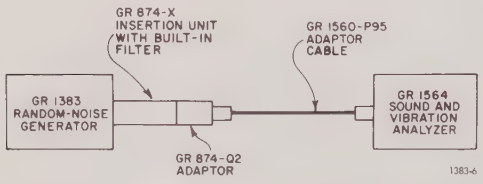


Figure 7-3. Connections for checking the spectrum at frequencies below 20 kHz.

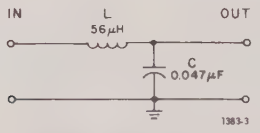


Figure 7-4. Low-pass filter to be built into a GR874-X Insertion Unit and used with a 50-Ω Termination Unit.

measurements made at lower frequencies must be multiplied by the factor $\sqrt{25000/f}$ to find the voltage that would be measured by an analyzer having constant bandwidth. The amount by which the resultant number differs from that measured at 25 kHz is the departure from perfect spectral flatness.

7.2.3 Amplitude Distribution.

As mentioned above, specially constructed equipment is used at General Radio for checking the amplitude distribution of noise generators before they leave the factory. Customers familiar with amplitude distribution measurements may have suitable equipment on hand, or at least will understand what sort of equipment is necessary, and how to assemble it. Others must make use of commercially available amplitude distribution analyzers, two of which will be discussed here.

A list of equipment that can be used in checking the amplitude density distribution is included in Table 7-1.

Sampling Unit Necessary.

Regardless of what equipment is used for the measurement, there is one important consideration in connection with the 1383: The bandwidth of the noise produced by it is much too wide for any conventional amplitude distribution measuring equipment. This problem can be overcome by using sampling techniques to reduce the bandwidth of the noise signal while preserving the amplitude distribution characteristics. This is most easily done with a sampling oscilloscope, which makes available as an output the "sampled-and-held" waveform. One such is the Tektronix 1S1 Sampling Plug-in Unit. It should be triggered from an external source of pulses at, say, a 20-kHz rate; the resulting rectangular sampled-and-held waveform is easily processed by amplitude distribution analyzers intended for audio-frequency use.

An important precaution in the use of such a sampling system is that the "sampling efficiency" *must* be adjusted to unity. Otherwise the hold capacitor will not be charged fully to the value of the noise waveform at the sampling instant, and the resulting output at each step will be some sort of average over the previous few samples; the amplitude distribution of the sampled-and-held output will not be representative of the noise. The manufacturer's procedure should be followed in setting the sampling efficiency to unity.

When using the Tektronix 1S1, connect the output of the 1383 by a 50-Ω cable to the 50-Ω input of the sampling unit. To avoid overloading the sampling unit, adequate attenuation should be inserted ahead of the sampler. This can be done conveniently with the output attenuator of the 1383.

It may be necessary to use a buffer amplifier at the output of the sampling unit, ahead of the amplitude distribution analyzer, either to increase the signal amplitude

TABLE 7-1

Equipment required for checking minimum performance standards.

INSTRUMENT	REQUIREMENTS	RECOMMENDED TYPE (or equivalent)
Analyzer	25 kHz - 20 MHz	Rhode & Schwarz Type USVH Selective Microvoltmeter or Hewlett-Packard Model 312A Wave Analyzer (usable to 18 MHz)
Analyzer	20 Hz - 25 kHz	GR Type 1564 Sound and Vibration Analyzer
Low-pass Filter	(See Figure 7-4)	Build in GR874-X Insertion Unit
Sampling Oscilloscope	>100 MHz input bandwidth, 50Ω input impedance, sampled-and-held output available	Tektronix Model 1S1 Sampling Unit in any Tektronix Type 530, 540, or 550 Oscilloscope
Pulse Generator	10-μs pulses at 20-kHz rate	GR Type 1340
Buffer Amplifier	Input impedance >100 kΩ bandwidth >200 kHz, voltage gain of 10, distortion <1%.	Hewlett-Packard Model 465-A
Amplitude Distribution Analyzer		B & K Model 161 or Quan-Tech Model 317
Counter	Counts at 10-MHz rate, multiple-period operation	GR Type 1191

or to lower the impedance of the sampled-and-held signal. If a buffer amplifier is used, it is extremely important that it have low distortion, as even small amounts of non-linear distortion can have a serious effect on the amplitude distribution of a random noise signal.

Use of the B & K Model 161 Amplitude Distribution Analyzer.

The B & K Model 161 Amplitude Distribution Analyzer will measure the amplitude density distribution of random noise. When making such measurements on the output of the 1383, sampling techniques will be necessary. (See above). In conjunction with a sampling oscilloscope, a buffer amplifier will probably be necessary to bring the signal to an adequate level. The amplifier should have distortion well under 1% and bandwidth flat to 200 kHz or more.

Measurements made with the B & K Model 161 should be made according to the manufacturer's instructions. The window width of the Model 161 is 0.1 σ while the specifications of the 1383 are given in terms of a window of 0.2 σ. The specified values, if divided by 2, will give values for a window of 0.1 σ with adequate accuracy. It will not be possible to read the panel meter of the B & K 161 with sufficient accuracy for measurements at 3 σ. Use a counter with the digital output according to the manufacturer's instructions. The test setup is shown in Figure 7-5.

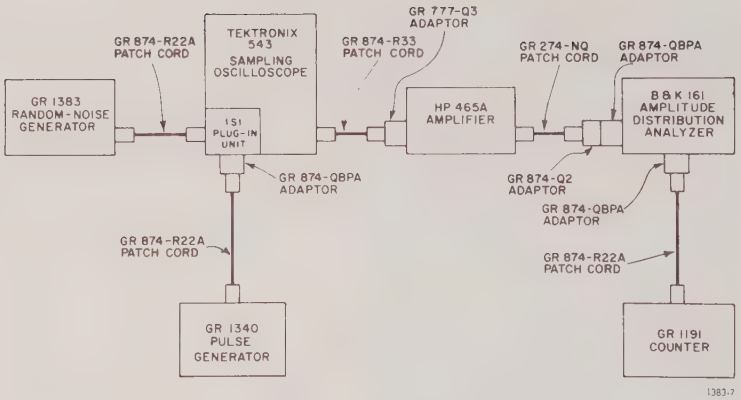


Figure 7-5. Test setup for measuring the amplitude density distribution using the B & K Analyzer.

Use of the Quan-Tech Model 317 Amplitude Distribution Analyzer.

The Quan-Tech Model 317 Amplitude Distribution Analyzer will not measure the amplitude density, but will measure the amplitude distribution. When it is used with the Tektronix Model 1S1 Sampling Unit, no buffer amplifier is necessary. Comparison of measured values of the amplitude distribution function with those for the Gaussian distribution given in Table 3-1 will show how closely the distribution function is Gaussian. Initial adjustment of the input level will have to be made with the front panel ATTEN and VAR ATTEN controls. An adequate way to proceed is to offset the LEVEL control (which sets the value of sigma at which the measurement is made) from its mid-range value by one unit (corresponding to one σ). The full range of this control is plus and minus 5 σ. The attenuators should then be set so that the meter indicates 15.8 percent. Then, if the LEVEL control is turned two units from mid-range, the meter should indicate 2.27%, etc. The manufacturer's instructions will be found helpful. The test setup is shown in Figure 7-6.

7.2.4 Other Tests.

Output Attenuator Accuracy.

The accuracy of the output attenuator can be checked by comparison with some other attenuator such as that in the Rhode & Schwarz USVH Selective Microvoltmeter. The comparison can be made at any frequency within the range of the two instruments, using the noise as the test signal.

Voltmeter Accuracy.

The voltmeter can be checked to its specified accuracy of ±5% by using a Ballantine Model 323 True-rms Voltmeter as a standard. Connect it to the output of the 1383 by a cable that is terminated at the voltmeter with an 874-W50B 50-Ω Termination, using an 874-T Tee and an 874-QBPA Adaptor (GR874 to BNC) to connect to the voltmeter. The termination, located at the voltmeter, ensures that there are no standing waves on the cable. The indication of the Model 323 Voltmeter will be half that of the panel meter (which indicates the open-circuit output voltage). Allow the 1383 to reach thermal equilibrium in its case so that temperature-compensation elements in the meter circuit will operate properly.

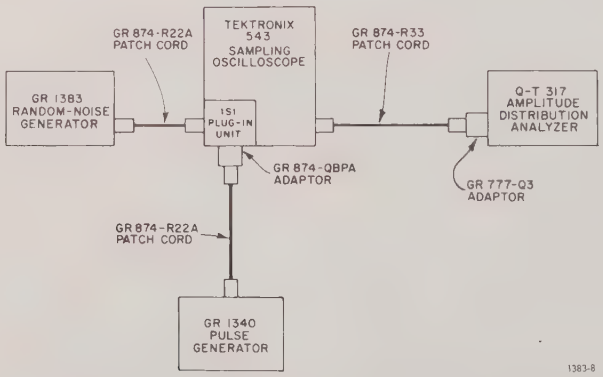


Figure 7-6. Test setup for measuring the amplitude distribution with the Quan-Tech Analyzer.

7.3 RECALIBRATION.

If repairs are made that include the replacement of some components, the internal controls noted below may have to be readjusted (see Figures 8-1 and 8-2). The required test equipment is listed in Table 7-2. Allow a ½-hour warm-up period, with the instrument in the cabinet, before making adjustments.

R525: This potentiometer is adjusted to set the voltage at the output of the regulated +10 V supply. Connect a dc voltmeter from AT531 (negative) to AT530 (positive) and set R525 so that the voltmeter indicates 10 V. The negative 10-V supply is controlled by the positive 10-V supply. If the negative supply is appreciably different from -10 V, measured from AT532 (negative) to AT531 (positive), R525 can be reset slightly to average the two magnitudes about 10 V.

R143: This potentiometer sets the magnitude of the dc plate current in the noise diode, V901, and thereby controls the magnitude of the noise output of the 1383. To set R143, turn the OUTPUT LEVEL control on the front panel fully clockwise and set the potentiometer so that the meter indicates full scale. Then turn the OUTPUT LEVEL control counterclockwise, to reduce the indication of the meter by 1 dB. Reset R143 to return the meter indication to full scale. This sets the noise level so that there is a reserve amplitude of 1 dB beyond full scale under normal conditions.

T202: Adjustment of the core inside this coil varies the frequency of the oscillator. Using a grid-dip meter, set the frequency of the oscillator to 60 MHz,±1MHz. When replacing the cover over the oscillator and modular board, tighten the four screws fairly tight, but not as tight as absolutely possible (the "finger stock" material makes the best grounding connections for shielding when not pressed absolutely flat).

R327: This potentiometer adjusts the dc bias conditions on the output stage, to compensate for different current gains in the output transistors, Q308 and Q309. Using a dc voltmeter, with the OUTPUT LEVEL control turned fully counterclockwise, adjust R327 so that the voltage from the collector of Q309 to ground is 2 V, positive. A further refinement of this adjustment is to observe the amplitude distribution of the noise at full amplitude output and adjust R327 for best symmetry. This is, however, a complicated procedure, and the simpler adjustment given first usually suffices to produce satisfactory results.

R322: This potentiometer adjusts the sensitivity of the voltmeter on the panel. To properly adjust this control, it is necessary to measure the output noise voltage. Connect the output, by means of a 50-Ω cable, to the input of the Ballantine 323 True-rms Voltmeter. The cable should be terminated at the voltmeter by an 874-W50B 50-Ω Termination using an 874-T Tee. An 874-QBPA Adaptor (GR874 to BNC) is useful in making closed connection to the voltmeter. With this arrangement, the cable is terminated in a matched load; therefore, the Ballantine 323 Voltmeter will read half the voltage indicated by the panel meter, which indicates the open-circuit output voltage. After the 1383 has been in its cabinet long enough to reach thermal equilibrium, set the OUTPUT LEVEL control so that the Ballantine Voltmeter reads exactly 0.5 V. Then slide the 1383 forward, out of its cabinet, and set R322 (on the under side) so that the panel meter indicates exactly 1 V.

TABLE 7-2

Equipment required for recalibration.

INSTRUMENT	REQUIREMENTS	RECOMMENDED
Voltmeter	True rms, 20 MHz upper frequency limit	Ballantine Model 323
Grid Dip Meter	Must cover 60 MHz	Millen No. 90651
Multimeter	20,000 Ω/V sensitivity	Triplett Model 630A

7.4 TROUBLE ANALYSIS.

A sine-wave signal of 40 to 80 MHz from a signal generator, such as the GR 1003, may be substituted for the noise source of the 1383. Apply the signal from the generator through a 1-kΩ resistance to AT101 of the 1383 with V901 removed. Set the OUTPUT LEVEL control fully cw and the METER FULL SCALE switch to 1 V. With the 1383 functioning properly, a 300-500 μV signal will give a full-scale meter deflection over the entire 40-80 MHz range.

A 500-μV, 50-MHz signal from the generator should produce a 15 mV signal at the output of the 40-80 MHz amplifier (AT102). This input should also produce a signal of approximately 500 mV, 10 MHz at the OUTPUT terminals.

TABLE 7-3
DC Test Voltages.

Conditions: Line, 115 V, ac, 60 Hz Meter Full Scale switch, 1 V Output Level, Full ccw

All voltages to chassis ground. Readings taken with 1806 Electronic Voltmeter or equivalent.

TEST POINT		DC VOLTS
Amplifier, 40–80 MHz		
Q101	E	+0.7
	C	–5.2
Q102	E	–5.8
	C	+0.03
Q103	E	–5.8
	C	–0.06
Q104	E	+0.7
	C	–5.2
Q105	E	–5.8
	C	0
Q106	E	–5.8
	C	–0.15
Q107	E	+0.65
	C	–5.2
Q108	E	–5.8
	C	0
Q109	E	–5.8
	C	–0.15
Local Oscillator, 60 MHz		
Q201A	E	–0.8
	C	0
Q201B	E	–0.8
	C	0
Q202	E	+0.05
	C	+9.6
Q203	E	–0.7
	C	+3.8
Q204	E	–0.7
	C	+9.6
Video Amplifier		
Q301	E	+0.75
	C	–5.2
Q302	E	–5.8
	C	–0.3
Q303	E	–5.8
	C	+0.5
Q304	E	+0.75
	C	–5.2
Q305	E	–6.0
	C	–0.5
Q306	E	–6.0
	C	–0.2
Q307	E	+0.7
	C	–5.0*
Q308	E	–5.6*
	C	–0.7*
Q309	E	–5.6*
	C	+2.0*
Q310	E	–0.8
	C	+3.0
Regulator, ±10 V		
Q501	E (AT527)	+15.0
	C	+13.5
Q502	E	+5.0
	C	+14.4
Q503	E (AT523)	+14.5
	C (AT530)	+10.0
Q504	E	0
	C	–14.0
Q505	E (AT529)	–15.0
	C	–13.5
Q506	E (AT526)	–14.0
	C (AT532)	–10.0
Filament Regulator		
Q110	E (AT109)	–60.0
	C	–62.0
Q111	E	–66.0
	C	–64.0
Q112	E	–64.0
	C	–60.0
Q901	E (AT106)	–66.0
	C (AT112)	–64.0
V901	#3 (AT112)	–64.0
	#4 (AT108)	–60.0

*Varies with setting of bias control, R327.

7.5 KNOB REMOVAL.

To remove the knob on a front-panel control, either to replace one that has been damaged or to replace the associated control, proceed as follows:

a. Grasp the knob firmly with the fingers, close into the panel (or the indicator dial, if applicable) and pull the knob straight, away from the panel.

CAUTION

Do not pull on the dial to remove a dial/knob assembly. Always remove the knob first.

b. Observe the position of the setscrew in the bushing, with respect to any panel markings (or at the full CCW position of a continuous control).

c. Release the setscrew with an Allen wrench and pull the bushing off the shaft.

d. Remove and retain the black nylon thrust washer, behind the dial/knob assembly, as appropriate.

NOTE

To separate the bushing from the knob, if for any reason they should be combined off the instrument, drive a machine-screw tap a turn or two into the bushing to provide sufficient grip for easy separation.

7.6 KNOB INSTALLATION.

To install a "Snap-on" knob assembly on the control shaft:

a. Place the black nylon thrust washer over the control shaft, if appropriate.

b. Mount the bushing on the shaft, using small slotted piece of wrapping paper as a shim for adequate clearance.

c. Orient the setscrew on the bushing with respect to the panel-marking index and lock the setscrew with an Allen wrench.

NOTE

Make sure that the end of the shaft does not protrude through the bushing or the knob won't seat properly.

d. Place the knob on the bushing with the retention spring opposite the setscrew.

e. Push the knob in until it bottoms and pull it slightly to check that the retention spring is seated in the bushing.

NOTE

If the retention spring in the knob comes loose, reinstall it in the interior notch with the small slit in the outer wall.

7.7 PILOT-LAMP REMOVAL.

To replace the pilot lamp (GE No. 328, GR P/N 5600-0300), remove the instrument from its cabinet. Insert a small screwdriver under the retaining strap at the rear of the lamp holder. Raise the end of the strap slightly and it will slide free, permitting the lamp to be withdrawn.

7.8 METER WINDOW CARE

The clear acrylic meter window can become susceptible to electrostatic-charge buildup and can be scratched, if improperly cleaned.

It is treated inside and out in manufacturing with a special non-abrasive anti-static solution, Statnul*, which normally should preclude any interference in meter operation caused by electrostatic effects. The problem is evidenced by the inability of the meter movement to return promptly to a zero reading, once it is deenergized. As supplied by General Radio, the meter should return to zero reading within 30 seconds, immediately following the placement of a static charge, as by rubbing the outside surface. This meets the requirements of ANSI standard C39.1-1972.

If static-charge problems occur, possibly as the result of frequent cleaning, the window should be carefully polished with a soft dry cloth, such as cheesecloth or nylon chiffon. Then, a coating of Statnul should be applied with the polishing cloth.

CAUTION

Do not use any kind of solvent. Kleenex or paper towels can scratch the window surface.

If it should be necessary to place limit marks on the meter window, paper-based masking tape is recommended, rather than any kind of marking pen, which could be abrasive or react chemically with the acrylic.

*Available from Mancib Co., Burlington, MA 01803

Parts Lists and Diagrams—Section 8

FEDERAL MANUFACTURER'S CODE

From Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) as supplemented through August, 1968.

Code	Manufacturer
00136	McCoy Electronics Co., Mt. Holly Springs, PA 17065
00192	Jones Mfg. Co., Chicago, IL 60607
00194	Walsco Electronics Corp., Los Angeles, CA 90053
00327	Welwyn International, Westlake, OH 44145
00434	Schweber Electronics, Westburg, NY 11590
00656	Aerovox Corp., New Bedford, MA 02745
00779	Amp, Inc., Harrisburg, PA 17105
01009	Alden Products Co., Brockton, MA 02413
01121	Allen-Bradley Co./Electronics Div., Milwaukee, WI 53204
01255	Litton Industries Inc., Beverly Hills, CA 90213
01295	Texas Instruments, Inc., Dallas, TX 75222
01930	Amerock, Corp., Rockford, IL 61101
02111	Spectrol Electronics Corp., City of Industry, CA 91745
02114	Ferroxcube Corp., Saugerties, NY 12477
02606	Fenwal Lab Inc., Morton Grove, IL 60053
02660	Amphenol Electron Corp., Broadview, IL 60153
02768	Fastex, Des Plains, IL 60016
03042	Carter Ink Co., Cambridge, MA 02142
03508	G. E. Semicon Prod., Syracuse, NY 13201
03636	Grayburne, Yonkers, NY 10701
03877	Transitron Electronics, Wakefield, MA 01880
03911	Clairex Corp., New York, NY 10001
04009	Arrow Hart, Hartford, CT 06106
04643	Digitronics Corp., Albertson, NY 11507
04713	Motorola, Phoenix, AZ 85008
04919	Component Mfg. Service, Inc., West Bridgewater, MA 02379
05079	Tansitor Electronics, Bennington, VT 05201
05402	Controls Co. of America, Melrose Park, IL 60160
05574	Viking Industries, Inc., Chatsworth, CA 91311
05624	Barber-Colman Co., Rockford, IL 61101
05748	Barnes Mfg. Co., Mansfield, OH 44901
05820	Wakefield Engineering Inc., Wakefield, MA 01880
06743	Clevite Corp., Cleveland, OH 44110
07126	Digitran Co., Pasadena, CA 91105
07127	Eagle Signal (E.W. Bliss Co.), Baraboo, WI 53913
07233	Cinch Graphik, City of Industry, CA 91744
07261	Avnet Corp., Culver City, CA 90230
07263	Fairchild Semiconductor, Mountain View, CA 94040
07387	Birtcher Corp., No. Los Angeles, CA 90032
07595	Amer. Semiconductor, Arlington Hts, IL 60004
07828	Bodine Corp., Bridgeport, CT 06605
07829	Bodine Electric Co., Chicago, IL 60618
07910	Cont. Device Corp., Hawthorne, CA 90250
07983	State Labs, Inc., New York, NY 10003
07999	Borg Instruments, Delavan, WI 53115
08730	Vemaline Products Co., Franklin Lakes, NJ 07417
09213	G. E. Semiconductor, Buffalo, NY 14207
09353	C & K Components Inc., Watertown, MA 02172
09408	Star-Tronics Inc., Georgetown, MA 01830
09823	Burgess Battery Co., Freeport, IL 61032
09856	Fenwal Electronics, Inc., Framingham, MA 01701
09922	Burndy Corp., Norwalk, CT 06852
11236	CTS of Berne, Inc., Berne, IN 46711
11599	Chandler Evans Corp., W. Hartford, CT 06101
11983	Nortronics Co., Inc., Minneapolis, MN 55427
12040	National Semiconductor, Santa Clara, CA 95051
12045	Electronic Transistors Corp., Flushing, NY 11354
12498	Teledyne Semiconductor, Mountain View, CA 94043
12617	Hamlin, Inc., Lake Mills, WI 53551
12672	R. C. A., Woodbridge, NJ 07095
12697	Clarostat Mfg. Co., Inc., Dover, NH 03820
12954	Dickson Electronics Corp., Scottsdale, AZ 85252
12969	Unitrode Corp., Watertown, MA 02172
13094	Electrocraft Corp., Hopkins, MN 55343
13103	Thermalloy, Inc., Dallas, TX 75234
13327	Solitron Devices, Tappan, NY 10983
13919	Burr Brown Research Corp., Tucson, AZ 85706
14195	Electronic Controls, Inc., Wilton, CT 06897
14433	I.T.T. Semiconductors, W. Palm Beach, FL 33402
14482	Watkins & Johnson Co., Palo Alto, CA 94304
14655	Cornell Dubilier Electronics, Newark, NJ 07101
14674	Corning Glass Works, Corning, NY 14830
14749	Acopian, Easton, PA 18042
14752	Electro Cube, Inc., San Gabriel, CA 91776
14936	General Instrument Corp., Hicksville, NY 11802
15116	Microdot Magnetics, Inc., Los Angeles, CA 90053
15238	I.T.T. Semiconductors, Lawrence, MA 08142
15476	Digital Equipment Corp., Maynard, MA 01754
15605	Cutler Hammer, Inc., Milwaukee, WI 53202
15782	Houston Instrument Corp., Bellaire, TX 77401
16037	Spruce Pine Mica Co., Spruce Pine, NC 28777
16179	Omni Spectra Mich Div., Farmington, MI 48024
16352	Computer Diode Corp., Lodi, NJ 07644
16636	Indiana General Corp., Oglesby, IL 61348
16758	Delco Electronic Div., GMC, Kokomo, IN 46901
16950	Precision Dynamics Corp., Burbank, CA 91504
16952	American Micro Devices, Inc., Summerville, SC 29483
17117	Electronic Molding Corp., Woonsocket, RI 02895
17771	Singer Co., Diehl Div., Somerville, NJ 08876
17850	Zeltex, Inc., Concord, CA 94520
17856	Siliconix, Inc., Santa Clara, CA 95054
18324	Signetics, Corp., Sunnyvale, CA 94086
18542	New Product Engineering Inc., Wabash, IN 46992
18677	Scanbe Manufacturing Corp., El Monte, CA 91731
18736	Voltronics Corp., Hanover, NJ 07936
18736	Computer Diode Corp., S. Fairlawn, NJ 07936
19048	Computer Diode Corp., S. Fairlawn, NJ 07410
19178	Zero Manufacturing Co., Monson, MA 01057
19373	Eastron Corp., Haverhill, MA 01830
19396	Illinois Tool Works, Pakton Div., Chicago, IL 60634
19617	Cabtron Corp., Chicago, IL 60622
19644	L.R.C. Electronics, Horseheads, NY 14845
19701	Electra Mfg. Co., Independence, KS 67301
20754	K.M.C. Semiconductor, Long Valley, NJ 07853
21335	Fafnir Bearing Co., New Britain, CT 06050
21759	Lenox-Fugle Electronics, Watchung, NJ 07060
22753	UID Electronics Div., AMF Inc., Hollywood, FL 33022
23338	Wavetek Div., John Fluke, San Diego, CA 92112
23342	Avnet Electronics Corp., Franklin Park, IL 60131
24355	Analog Devices, Cambridge, MA 02142
24446	General Electric, Schenectady, NY 12305
24454	General Electric Electronics Comp., Syracuse, NY 13201
24455	General Electric Lamp Div., Cleveland, OH 44112
24602	E.M.C. Technology, Cherry Hill, NJ 08034
24655	General Radio Co., Concord, MA 01742
25289	E. G. & G. Inc., Bedford, MA 01730
26806	American Zettler, Inc., Costa Mesa, CA 92626
28480	Hewlett Packard, Palo Alto, CA 04304
28520	Heyman Mfg. Co., Kenilworth, NJ 07033
28959	Hoffman Electronics Corp., El Monte, CA 91734
30646	Beckman Instruments, Inc., Cedar Grove, NJ 07009
30874	I.B.M., Armonk, NY 10504
32001	Jensen Mfg. Co., Chicago, IL 60638
33173	General Electric Comp., Owensboro, KY 42301
34141	Koehler Mfg. Co., Inc., Marlboro, MA 01752
35929	Constanta, Co., Montreal Quebec
37942	P. R. Mallory & Co., Inc., Indianapolis, IN 46206
38443	Marlin-Rockwell Corp., Jamestown, NY 14701
39317	McGill Manufacturing Co., Inc., Valparso, IN 46383
40931	Honeywell, Inc., Minneapolis, MN 55408
42190	Muter Co., Chicago, IL 60638
42498	National Co., Inc., Melrose, MA 02176
43991	Norma Hoffman, Stanford, CT 06904
49671	R. C.A., New York, NY 10020
49956	Raytheon Mfg. Co., Waltham, MA 02154
50088	Mostek, Carrollton, TX 75006
53021	Sangamo Electric Co., Springfield, IL 62705
54294	Shallcross Mfg. Co., Selma, NC 27576
54715	Shure Brothers, Inc., Evanston, IL 60202
56289	Sprague Electric Co., North Adams, MA 01247
59730	Thomas & Betts Co., Elizabeth, NJ 07207
59875	T.R.W. Inc., (Accessories Div), Cleveland, OH 44117
60399	Torrington Mfg. Co., Torrington, CT 06790
61637	Union Carbide Corp., New York, NY 10017
61864	United-Carr Fastener Corp., Boston, MA 02142
63060	Victoreen Instrument Co., Cleveland, OH 44104
63743	Ward Leonard Electric, Mt. Vernon, NY 10550
65083	Westinghouse (Lamp Div), Bloomfield, NJ 07003
65092	Weston Instruments, Newark, NJ 07114
70106	Acushnet Capacitor Co., New Bedford, MA 02742
70109	Adams and Westlake Co., Elkhart, IN 46514
70485	Atlantic India Rubber Works, Inc., Chicago, IL 60607
70563	Amperite Co., Union City, NJ 07087
70903	Belden Mfg. Co., Chicago, IL 60644
71126	Bronson Homer D., Beacon Falls, CT 06403
71279	Cambridge Thermionic, Corp., Cambridge, MA 02138
71294	Canfield Co., Clifton Forge, VA 24422
71400	Bussmann Mfg. Co., St. Louis, MO 63107
71450	CTS Corp., Elkhart, IN 46514
71468	ITT-Cannon Electric Inc., Los Angeles, CA 90031
71482	C.P. Clare & Co., Chicago, IL 60645
71590	Centralab, Inc., Milwaukee, WI 53212
71666	Continental Carbon Co., Inc., New York, NY 10001
71707	Coto Coil Co., Inc., Providence, RI 02905
71729	Crescent Box Corp., E. Philadelphia, PA 19134
71744	Chicago Miniature Lamp., Chicago, IL 60640
71785	Cinch Jones, Chicago, IL 60624
71823	Darnell Corp., Ltd., Downey, CA 90241
72136	Electromotive Mfg. Co., Willimantic, CT 06226
72228	Continental Screw Co., New Bedford, MA 02742
72259	Nytronics, Inc., Berkeley Hts, NJ 07922
72619	Dialight Co., Brooklyn, NY 11237
72699	General Instrument Corp., Newark, NJ 07104
72765	Drake Mfg. Co., Chicago, IL 60631
72794	Dzus Fastener Co., Inc., West Islip, NY 11795
72825	Eby Co., Hugh H, Philadelphia, PA 19144
72962	Elastic Stop Nut Corp., Union, NJ 07083
72982	Erie Technological Products, Erie, PA 16512
73445	Amperex Electronic Corp., Hicksville, LI, NY 11801
73559	Carling Electric Co., W. Hartford, CT 06110
73690	Elco Resistor Co., New York, NY 10001
73899	J.F.D. Electronics Corp., Brooklyn, NY 11219
73957	Groov-Pin Corp., Ridgefield, NJ 07657
74193	Heinemann Electric Co., Trenton, NJ 08602
74545	Hubbell, Stratford, CT 06497
74861	Industrial Condenser Corp., Chicago, IL 60618
74868	Amphenol RF Division, Danbury, CT 06810
74970	Johnson Co., E.F., Waseca, MN 56093
75042	IRC Div. of TRW, Burlington, IA 52601
75382	Kulka Electric Corp., Mt. Vernon, NY 10551
75491	Lafayette Industrial Electronics, Syosset, NY 11791
75608	Linden & Co., Providence, RI 02905
75915	Littelfuse, Inc., Des Plaines, IL 60016
76005	Lord Mfg. Co., Erie, PA 16512
76149	Mallory Electric Corp., Detroit, MI 48204
76381	Minnesota Mining., St. Paul, MN 55101
76487	Millen Mfg. Co., Inc., Malden, MA 02148
76545	Mueller Electric Co., Cleveland, OH 44114
76684	National Tube Co., Pittsburg, PA 15230
76854	Oak Mfg. Co., Crystal Lake, IL 60014
77147	Patton MacGuyer Co., Providence, RI 02905
77166	Pass-Seymour, Syracuse, NY 13209
77263	Pierce-Roberts Rubber Co., Trenton, NJ 08638
77339	Positive Lockwasher Co., Newark, NJ 07101
77342	American Machine & Foundry Co., Princeton, IN 47570
77542	Ray-O-Vac Co., Madison, WI 53703
77630	T.R.W. Electronic Comp., Camden, NJ 08103
77638	General Instruments Corp., Brooklyn, NY 11211
78189	Shakeproof (Ill. Tool Wks), Elgin, IL 60120
78277	Sigma Instruments Inc., South Braintree, MA 02184
78488	Stackpole Carbon Co., St. Mary's, PA 15827
78553	Tinnerman Products, Inc., Cleveland, OH 44101
79089	R.C.A. Rec. Tube & Semicond., Harrison, NJ 07029
79136	Waldes Kohinoor Co., New York, NY 11101
79725	Wiremold Co., Hartford, CT 06110
79727	Continental WIRT Electronics Corp., Philadelphia, PA 19101
79963	Zierick Mfg. Co., Mount Kisco, NY 10549
80009	Tektronix, Inc., Beaverton, OR 97005
80030	Prestole Fastener, Toledo, OH 43605
80048	Vickers Inc., St. Louis, MO 63166
80103	Lambda Electronics Corp., Melville, NY 11746
80183	Sprague Products Co., North Adams, MA 01247
80211	Motorola Inc., Franklin Park, IL 60131
80251	Formica Corp., Cincinnati, OH 45232
80258	Standard Oil Co., Lafeyette, IN 47902
80294	Bourns Laboratories, Inc., Riverside, CA 92506
80368	Sylvania Electric Products, Inc., New York, NY 10017
80431	Air Filter Corp., Milwaukee, WI 53218
80583	Hammarlund Co., Inc., New York, NY 10010
80894	Pure Carbon Co., St. Mary's, PA 15857
81030	International Instrument, Orange, CT 06477
81073	Grayhill Inc., LaGrange, IL 60525
81143	Isolantite Mfg. Corp., Stirling, NJ 07980
81312	Winchester Electronics Co., Inc., Oakville, CT 06779
81349	Military Specifications
81350	Joint Army-Navy Specifications
81483	International Rectifier Corp., El Segundo, CA 90245
81751	Columbus Electronics Corp., Yonkers, NY 10701
81831	Filtron Co., Flushing, NY 11354
81860	Barry Wright Corp., Watertown, MA 02172
82219	Sylvania Elec. Prod., Emporium, PA 15834
82273	Indiana Pattern & Model Works, LaPort, IN 46350
82389	Switchcraft, Inc., Chicago, IL 60630
82647	Metals & Controls, Inc., Attleboro, MA 02703
82807	Milwaukee Resistor Co., Milwaukee, WI 53204
82877	Rotron Mfg. Co., Inc., Woodstock, NY 12498
83003	Varo Semiconductor Div., Garland, TX 75040
83033	Meissner Mfg., Mt. Carmel, IL 62863
83058	Carr Fastener Co., Cambridge, MA 02142
83186	Victory Engineering, Springfield, NJ 07081
83361	Bearing Specialty Co., San Francisco, CA 94101
83587	Solar Electric Corp., Warren, PA 16365
83594	Burroughs Corp., Plainfield, NJ 07061
83740	Union Carbide Corp., New York, NY 10017
84411	TRW Capacitor Division, Ogallala, NB 69153
84835	Lehigh Metal Products, Cambridge, MA 02140
84970	Sarkes Tarzian, Inc., Bloomington, IN 47401
84971	T.A. Mfg. Corp., Los Angeles, CA 90039
86577	Precision Metal Products, Stoneham, MA 02180
86684	R.C.A. (Elec. Comp. & Dev), Harrison, NJ 07029
86687	R.E. C. Corp., New Rochelle, NY 10801
86800	Cont. Electronics Corp., Brooklyn, NY 11222
88140	Cutler-Hammer Inc., Lincoln, IL 62656
88219	Gould Nat. Batteries, Inc., Trenton, NJ 08607
88419	Cornell Dubilier, Fuquay-Varina, NC 27526
88627	K & G Mfg. Co., New York, NY 10001
89482	Holtzer Cabot Corp., Boston, MA 02119
89665	United Transformer Co., Chicago, IL 60607
89870	Berkshire Transformer Corp., Kent, CT 06757
90201	Mallory Capacitor Co., Indianapolis, IN 46206
90303	Mallory Battery Co., Tarrytown, NY 10591
90634	Gulton Industries, Inc., Metuchen, NJ 08840
90750	Westinghouse Electric Corp., Boston, MA 02118
90952	Hardware Products Co., Reading, PA 19602
91032	Continental Wire Corp., York, PA 17405
91146	I.T.T. (Cannon), Salem, MA 01970
91210	Gerber Mfg. Co., Mishawaka, IN 46544
91293	Johanson Mfg. Co., Boonton, NJ 07005
91417	Harris Semiconductor, Melbourne, FL 32901
91506	Augat Brothers, Inc., Attleboro, MA 02703
91598	Chandler Co., Wethersfield, CT 06109
91637	Dale Electronics, Inc., Columbus, NE 68601
91662	Elco Corp., Willow Grove, PA 19090
91719	General Instruments Corp., Dallas, TX 75220
91836	Kings Electronics, Co., Inc., Tuckahoe, NY 11223
91916	Mephisto Tool Co., Inc., Hudson, NY 12534
91929	Honeywell, Inc., Freeport, IL 61032
92519	Electra Insul. Corp., Woodside, LI., NY 11377
92678	Edgerton Germeshuasen, Georgetown, MA 01830
92702	I.M.C. Magnetics Corp., Westbury, NY 11591
92739	Ampex Corp., Redwood City, CA 94063
92966	Hudson Lamp Co., Kearny, NJ 07032
93332	Sylvania Elect. Prods., Inc., Woburn, MA 01801
93618	R & C Mfg. Co. of Penn, Inc., Ramsey, PA 16671
93916	Cramer Products Co., New York, NY 10013
94144	Raytheon Co., Components Div., Quincy, MA 02169
94154	Tung Sol Electric Inc., Newark, NJ 07101
94271	Weston Instruments, Inc., Archibald, PA 18403
94322	Tel Labs, Manchester, NH 03102
94589	Dickson Co., Chicago, IL 60619
94696	Magnecraft Electric Co., Chicago, IL 60630
94800	Atlas Industrial Corp., Brookline, NH 03033
95076	Garde Mfg. Co., Cumberland, RI 02864
95121	Quality Components, Inc., St. Marys, PA 15857
95146	Alco Electronics Mfg. Co., Lawrence, MA 01843
95238	Continental Connector Corp., Woodside, NY 11377
95275	Vitramon, Inc., Bridgeport, CT 06601
95348	Gordos Corp., Bloomfield, NJ 07003
95354	Methode Mfg. Co., Rolling Meadow, IL 60008
95794	American Brass Co., Torrington, CT 06790
95987	Weckesser Co., Inc., Chicago, IL 60646
96095	Hi Q Division of Aerovox Corp., Olean, NY 14760
96341	Microwave Associates, Inc., Burlington, MA 01801
96906	Military Standards,
98291	Sealectro Corp., Mamaroneck, NY 10544
98474	Compar, Inc., Burlingame, CA 94010
98821	North Hills Electronic, Glen Cove, NY 11542
99117	Metavac, Inc., Flushing, NY 11358
99313	Varian Associates, Palo Alto, CA 94303
99378	Atlee Corp., Winchester, MA 01890
99800	Delevan Electronics, East Aurora, NY 14052

MECHANICAL PARTS LIST

Name	*Description*	*GR Part Number*	*FMC*	*Mfg. Part Number*
Cabinet	Complete, Convertible-Bench	4181-2646	24655	4181-2646
Meter Cover	ME3-701, light gray	5720-3713	24655	5720-3713
Knob Asm.	OUTPUT LEVEL Knob, including retainer 5220-5402	5520-5321	24655	5520-5321
Dial Asm.	METER FULL SCALE dial, including retainer 4123-3241	1383-1110	24655	1383-1110
Knob Asm.	METER FULL SCALE Knob, including retainer 5220-5402	5500-5321	24655	5500-5321
Cover Plate	OUTPUT Cover Plate, Complete	0480-2470	24655	0480-2470
Dress Nut	For Power Toggle Switch, 15/32—32, Dress	5800-0800	24655	5800-0800
Foot	Rear, black Neoprene Foot	5260-2060	24655	5260-2060
Foot	Right, front black Phenolic Foot for use with Bail	5250-2121	24655	5250-2121
	Left, front black Phenolic Foot, for use with Bail	5250-2120	24655	5250-2120
Bail	Tilt-bar support	5250-2125	24655	5250-2125
Fuseholder	Extraction-post Fuse-mounting Device	5650-0100	71400	HKP-H
	Output Connector Assembly	0874-4624	24655	0874-4624
	Panel Jack	0874-6690	24655	0874-6690

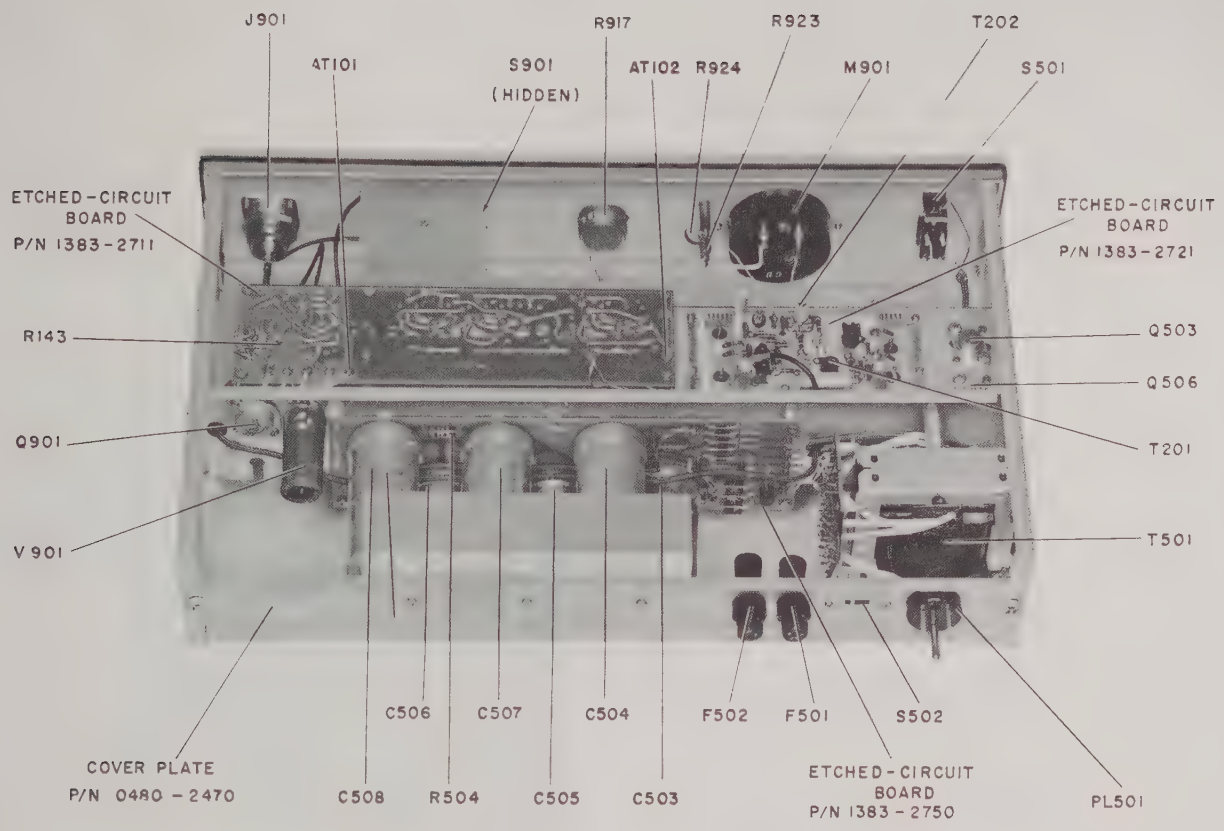


Figure 8-1. Top interior view of the Generator.

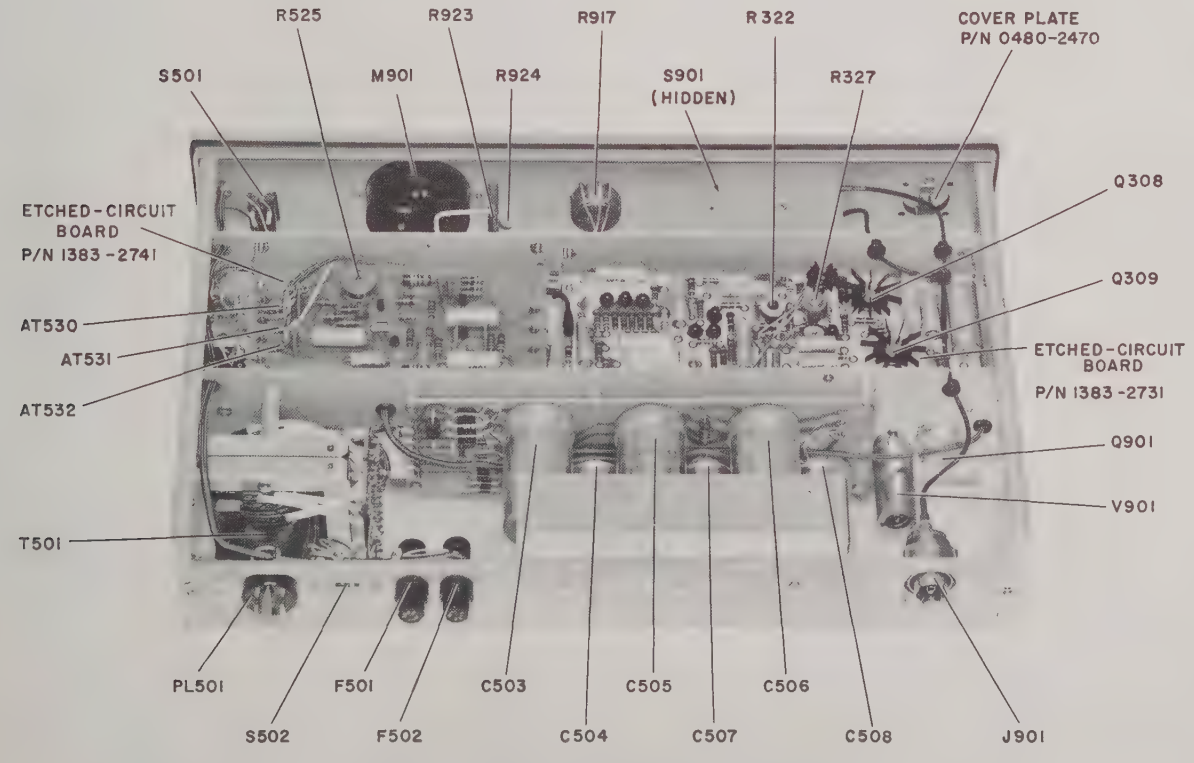


Figure 8-2. Bottom interior view of the Generator.

40-80MHZ AMPLIFIER CIRCUIT P/N 1383-2711

REFDES	DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
C 101	CAP CER DISC.01UF 80/20PCT 500VU	4406-3109	72982	0811082Z5U00103Z
C 102	CAP CER DISC 1000PF 5PCT 500V	4405-2105	72982	0801082Z5D00102J
C 103	CAP CER MONO 0.1UF 20PCT 50VGP	4400-2050	72982	8131-M050-651-104M
C 104	CAP CER DISC 33PF 5PCT 500V	4404-0335	72982	0831082Z5D00330J
C 105	CAP CER DISC 1000PF 5PCT 500V	4405-2105	72982	0801082Z5D00102J
C 106	CAP CER DISC 1000PF 5PCT 500V	4405-2105	72982	0801082Z5D00102J
C 107	CAP CER DISC 1000PF 5PCT 500V	4405-2105	72982	0801082Z5D00102J
C 108	CAP CER DISC 33PF 5PCT 500V	4404-0335	72982	0831082Z5D00330J
C 109	CAP CER DISC 1000PF 5PCT 500V	4405-2105	72982	0801082Z5D00102J
C 110	CAP CER DISC 51PF 5PCT 500V	4404-0515	72982	0831082Z5D00510J
C 111	CAP CER DISC 56PF 5PCT 500V	4404-0565	72982	0831082Z5D00560J
C 112	CAP CER DISC 1000PF 5PCT 500V	4405-2105	72982	0801082Z5D00102J
C 113	CAP CER DISC 33PF 5PCT 500V	4404-0335	72982	0831082Z5D00330J
C 114	CAP CER DISC 1000PF 5PCT 500V	4405-2105	72982	0801082Z5D00102J
C 116	CAP CER MONO 0.1UF 20PCT 50VGP	4400-2050	72982	8131-M050-651-104M
C 117	CAP CER DISC 1000PF 5PCT 500V	4405-2105	72982	0801082Z5D00102J
C 118	CAP CER DISC 1000PF 5PCT 500V	4405-2105	72982	0801082Z5D00102J
C 119	CAP CER DISK 0.1UF 80/20PCT 12V	4431-4109	72982	5655008Y5F00104Z
C 120	CAP CER DISC 1000PF 5PCT 500V	4405-2105	72982	0801082Z5D00102J
C 121	CAP CER DISC 1000PF 5PCT 500V	4405-2105	72982	0801082Z5D00102J
C 122	CAP CER DISC 1000PF 5PCT 500V	4405-2105	72982	0801082Z5D00102J
C 123	CAP CER MONO 0.1UF 20PCT 50VGP	4400-2050	72982	8131-M050-651-104M
C 124	CAP CER DISC.01UF 80/20PCT 500VU	4406-3109	72982	0811082Z5U00103Z
C 125	CAP CER DISC.01UF 80/20PCT 500VU	4406-3109	72982	0811082Z5U00103Z
C 126	CAP CER DISC.01UF 80/20PCT 500VU	4406-3109	72982	0811082Z5U00103Z
CR 101	ZENER CD332588 5.1V 1PCT .4W	6083-1076	C7910	CD332588
CR 102	ZENER 1N748A 3.9V 5PCT .4W	6083-1002	14433	IN748A
CR 103	DIODE 1N4154 25PIV IR.1UA SI	6082-1012	14433	IN4154
CR 104	DIODE 1N4154 25PIV IR.1UA SI	6082-1012	14433	IN4154
CR 105	DIODE 1N4154 25PIV IR.1UA SI	6082-1012	14433	IN4154
L 101	CHOKE MOLDED 0.15 UH 10 PCT D	4300-0101	24655	4300-0101
L 102	CHOKE MOLDED 0.15 UH 10 PCT D	4300-0101	24655	4300-0101
Q 101	TRANSISTOR 2N3250	8210-1089	04713	2N3250
Q 102	TRANSISTOR K-2037	8210-1088	20754	K-2037
Q 103	TRANSISTOR 2N3646	8210-1293	07263	PN3646
Q 104	TRANSISTOR 2N3640	8210-1129	07263	2N3640
Q 105	TRANSISTOR K-2037	8210-1088	20754	K-2037
Q 106	TRANSISTOR 2N3646	8210-1293	07263	PN3646
Q 107	TRANSISTOR 2N3640	8210-1129	07263	2N3640
Q 108	TRANSISTOR K-2037	8210-1088	20754	K-2037
Q 109	TRANSISTOR 2N3646	8210-1293	07263	PN3646
Q 110	TRANSISTOR 2N3905	8210-1114	04713	2N3905
Q 111	TRANSISTOR 2N3414	8210-1290	56289	2N3414
Q 112	TRANSISTOR 2N3414	8210-1290	56289	2N3414
R 101	RES COMP 47 OHM 5PCT 1/4W	6099-0475	81349	RCR07G470J
R 102	RES COMP 560 OHM 5PCT 1/4W	6099-1565	81349	RCR07G561J
R 103	RES FLM 90.9 OHM 1 PCT 1/8W	6250-9909	81349	RN55D90R9F
R 104	RES FLM 10 OHM 1 PCT 1/8W	6250-9100	81349	RN55D10R0F

ELECTRICAL PARTS LIST (cont)

40-80MHZ AMPLIFIER CIRCUIT P/N 1383-2711

REFDES	DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
R 105	RES COMP 510 OHM 5PCT 1/4W D	6099-1515	81349	RCR07G511J
R 106	RES COMP 220 OHM 5PCT 1/4W	6099-1225	81349	RCR07G221J
R 107	RES COMP 910 OHM 5PCT 1/4W D	6099-1915	81349	RCR07G911J
R 110	RES COMP 10 OHM 5PCT 1/4W	6099-0105	81349	RCR07G100J
R 111	RES COMP 10 OHM 5PCT 1/4W	6099-0105	81349	RCR07G100J
R 112	RES COMP 560 OHM 5PCT 1/4W	6099-1565	81349	RCR07G561J
R 113	RES FLM 90.9 OHM 1 PCT 1/8W	6250-9909	81349	RN55D90R9F
R 114	RES FLM 10 OHM 1 PCT 1/8W	6250-9100	81349	RN55D10R0F
R 115	RES COMP 510 OHM 5PCT 1/4W D	6099-1515	81349	RCR07G511J
R 116	RES COMP 220 OHM 5PCT 1/4W	6099-1225	81349	RCR07G221J
R 117	RES COMP 910 OHM 5PCT 1/4W D	6099-1915	81349	RCR07G911J
R 120	RES COMP 10 OHM 5PCT 1/4W	6099-0105	81349	RCR07G100J
R 121	RES COMP 10 OHM 5PCT 1/4W	6099-0135	81349	RCR07G100J
R 122	RES COMP 47 OHM 5PCT 1/4W	6099-0475	81349	RCR07G470J
R 123	RES COMP 560 OHM 5PCT 1/4W	6099-1565	81349	RCR07G561J
R 124	RES FLM 90.9 OHM 1 PCT 1/8W	6250-9909	81349	RN55D90R9F
R 125	RES FLM 10 OHM 1 PCT 1/8W	6250-9100	81349	RN55D10R0F
R 126	RES COMP 510 OHM 5PCT 1/4W D	6099-1515	81349	RCR07G511J
R 127	RES COMP 220 OHM 5PCT 1/4W	6099-1225	81349	RCR07G221J
R 128	RES COMP 910 OHM 5PCT 1/4W D	6099-1915	81349	RCR07G911J
R 131	RES COMP 470 OHM 5PCT 1/4W	6099-1475	81349	RCR07G471J
R 132	RES COMP 470 OHM 5PCT 1/4W	6099-1475	81349	RCR07G471J
R 133	RES COMP 470 OHM 5PCT 1/4W	6099-1475	81349	RCR07G471J
R 134	RES COMP 5.1 K OHM 5PCT 1/4W D	6099-2515	81349	RCR07G512J
R 135	RES COMP 680 OHM 5PCT 1/2W	6100-1685	81349	RCR20G681J
R 136	RES COMP 100 OHM 5PCT 1/2W	6100-1105	81349	RCR20G101J
R 137	RES COMP 100 OHM 5PCT 1/2W	6100-1105	81349	RCR20G101J
R 138	RES COMP 510 OHM 5PCT 1/2W D	6100-1515	81349	RCR20G511J
R 139	RES COMP 680 OHM 5PCT 1/2W	6100-1685	81349	RCR20G681J
R 140	RES COMP 62 OHM 5PCT 1/2W D	6100-0625	81349	RCR20G620J
R 141	RES COMP 150 OHM 5PCT 1/2W	6100-1155	81349	RCR20G151J
R 143	POT WW TRM 300 OHM 10 PCT 1T	6056-0135	24655	6056-0135
R 144	RES COMP 10 OHM 5PCT 1/4W	6099-0105	81349	RCR07G100J
R 145	RES COMP 10 OHM 5PCT 1/4W	6099-0105	81349	RCR07G100J
T 101	TRANS TOPR 2WIND USED ON 1383 U	5000-2711	24655	5000-2711

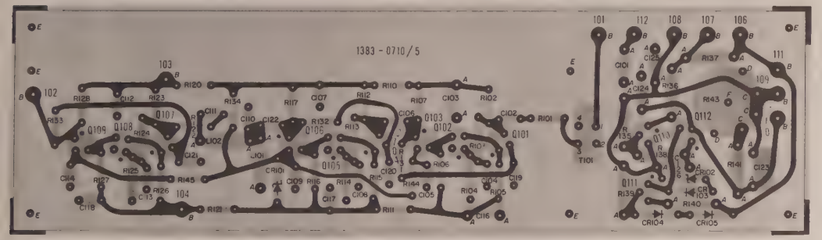
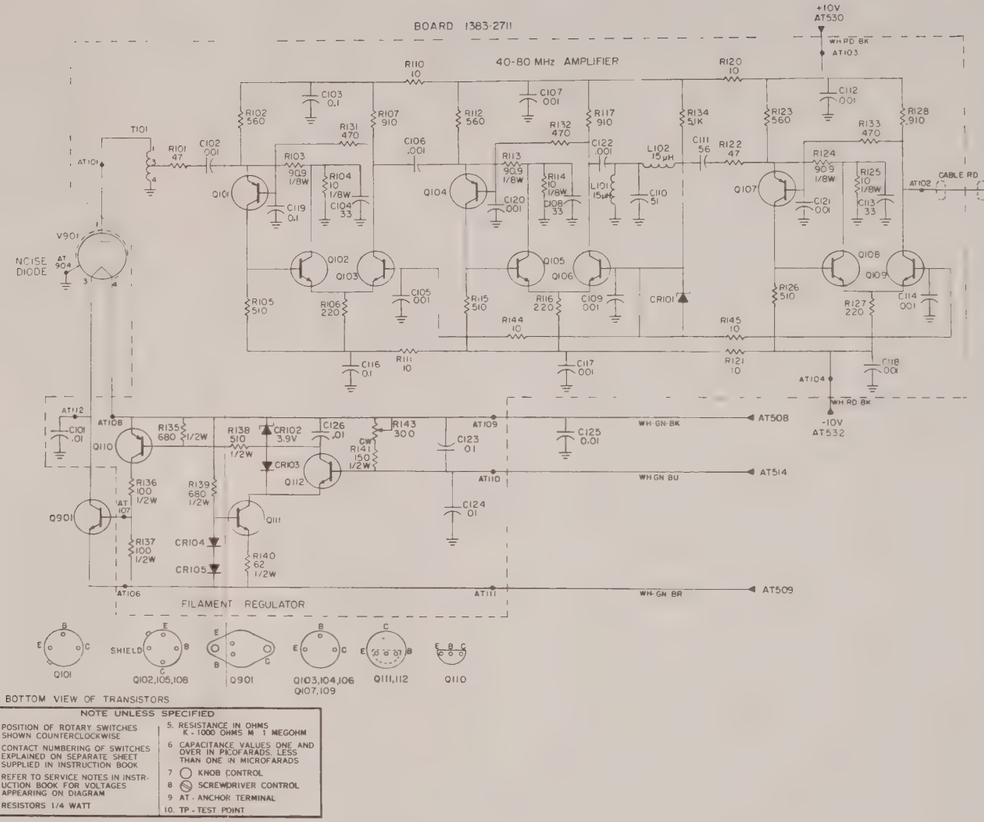


Figure 8-3. Etched-circuit-board assembly for the 40-80-MHz amplifier. The complete board is P/N 1383-2711.

NOTE: The number appearing on the foil side is not the part number. The dot on the foil at the transistor socket indicates the collector lead.



NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM
4. RESISTORS 1/4 WATT
5. RESISTANCE IN OHMS K - 1000 OHMS M - 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS
7. KNOB CONTROL
8. SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP - TEST POINT

Figure 8-4. Schematic circuit diagram of the 40-80-MHz amplifier.

ELECTRICAL PARTS LIST

LOCAL OSCILLATOR 60 MHZ CIRCUIT P/N 1383-2721

REFDES	DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
C 201	CAP CER DISC 1000PF 80/20PCT 500	4404-2109	72982	0831082Z5U00102Z
C 202	CAP CER DISC 1000PF 80/20PCT 500	4404-2109	72982	0831082Z5U00102Z
C 203	CAP CER DISC 1000PF 80/20PCT 500	4404-2109	72982	0831082Z5U00102Z
C 204	CAP CER DISC 22PF 5PCT 500V NPO	4410-0225	72982	0801082C0G00220J
C 205	CAP CER DISC 220PF 5PCT 500V	4404-1225	72982	0831082Z5D00221J
C 206	CAP CER DISC 1000PF 80/20PCT 500	4404-2109	72982	0831082Z5U00102Z
C 207	CAP CER DISC 10PF 10PCT 500V	4404-0108	72982	0831082Z5F00100K
C 208	CAP CER DISC 1000PF 80/20PCT 500	4404-2109	72982	0831082Z5U00102Z
C 210	CAP ALUM 100 UF 15V	4450-2800	56289	30D107G015
CR 201	DIODE MS7331 15PIV IR.1UA GA/AS	6082-1027	13327	MS-7331
CR 202	DIODE MS7331 15PIV IR.1UA GA/AS	6082-1027	13327	MS-7331
CR 203	DIODE MS7331 15PIV IR.1UA GA/AS	6082-1027	13327	MS-7331
CR 204	DIODE MS7331 15PIV IR.1UA GA/AS	6082-1027	13327	MS-7331
Q 201	TRANSISTOR TO-100	8210-1130	56289	TO-100
Q 202	TRANSISTOR 2N2369	8210-1052	07263	2N2369
Q 203	TRANSISTOR 2N3646	8210-1293	07263	PN3646
Q 204	TRANSISTOR 2N3646	8210-1293	07263	PN3646
R 201	RES COMP 150 OHM 5PCT 1/4W	6099-1155	81349	RCR07G151J
R 202	RES COMP 47 OHM 5PCT 1/4W	6099-0475	81349	RCR07G470J
R 203	RES COMP 1.5 K 5PCT 1/4W	6099-2155	81349	RCR07G152J
R 204	RES COMP 150 OHM 5PCT 1/4W	6099-1155	81349	RCR07G151J
R 205	RES COMP 4.7 K 5PCT 1/4W	6099-2475	81349	RCR07G472J
R 206	RES COMP 10 OHM 5PCT 1/4W	6099-0105	81349	RCR07G100J
R 207	RES COMP 20 OHM 5PCT 1/4W D	6099-0205	81349	RCR07G200J
R 208	RES COMP 24 OHM 5PCT 1/4W D	6099-0245	81349	RCR07G240J
R 209	RES COMP 24 OHM 5PCT 1/4W D	6099-0245	81349	RCR07G240J
R 210	RES COMP 20 OHM 5PCT 1/4W D	6099-0205	81349	RCR07G200J
R 211	RES COMP 10 OHM 5PCT 1/4W	6099-0105	81349	RCR07G100J
R 212	RES COMP 3.0 K OHM 5PCT 1/4W D	6099-2305	81349	RCR07G302J
R 213	RES COMP 910 OHM 5PCT 1/4W D	6099-1915	81349	RCR07G911J
R 214	RES COMP 910 OHM 5PCT 1/4W D	6099-1915	81349	RCR07G911J
R 215	RES COMP 100 OHM 5PCT 1/4W	6099-1105	81349	RCR07G101J
T 201	TRANS TORR 2WIND USED ON 1383 U	5000-2710	24655	5000-2710
T 202	TRANSFORMER ASM	1383-2200	24655	1383-2200

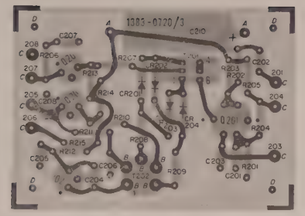


Figure 8-5. Etched-circuit-board assembly for the oscillator and modulator. The complete board is P/N 1383-2721.

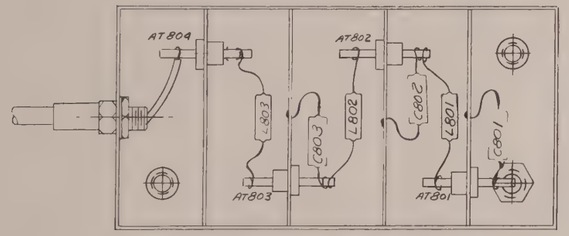
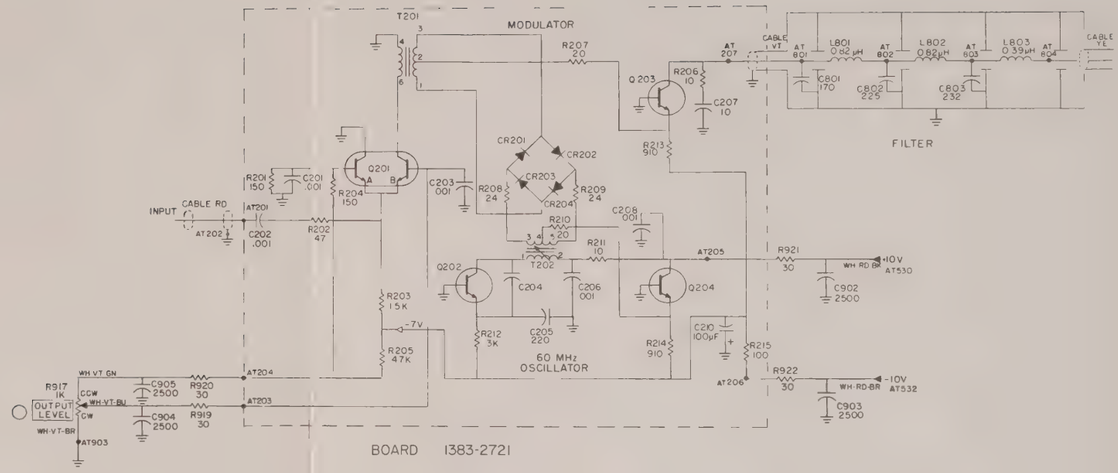


Figure 8-6. The 20-MHz low-pass filter is hidden by the regulator circuit etched board, P/N 1383-2741 (refer to paragraph 4-1).

NOTE: The number appearing on the foil side is not the part number. The dot on the foil at the transistor socket indicates the collector lead.



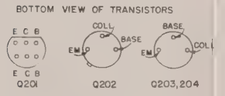


Figure 8-7. Schematic circuit diagram of the oscillator, modulator, and 20-MHz low-pass filter.

NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM
4. RESISTORS 1/2 WATT
5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS
7. ◯ KNOB CONTROL
8. ⊖ SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP - TEST POINT

ELECTRICAL PARTS LIST

MAIN FRAME P/N 1383-3000

REFDES	DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
C 801	CAP MICA 170PF 1PCT 500V	4710-0170	81349	CM05FD170FN
C 802	CAP MICA 255PF 1PCT 500V	4710-0434	81349	CM05FD255FN
C 803	CAP MICA 232PF 1PCT 500V	4710-0411	81349	CM05FD232FN
C 902	FILTER ELEC 2500 PF	5280-0130	72982	1202-056
C 903	FILTER ELEC 2500 PF	5280-0100	72982	1202-056
C 904	FILTER ELEC 2500 PF	5280-0100	72982	1202-056
C 905	FILTER ELEC 2500 PF	5280-0100	72982	1202-056
F 501	FUSE SLO-BLOW 6/10A 250V	5330-1100	75915	313 .600
F 502	FUSE SLO-BLOW 3/10A 250V	5330-0800	75915	313 .300
L 801	CHOKE MOLDED 0.82 UH 10PCT	4300-7524	72259	DD-0.82
L 802	CHOKE MOLDED 0.82 UH 10PCT	4300-7524	72259	DD-0.82
L 803	CHOKE MOLDED 0.39 UH 10PCT	4300-7523	72259	DD-0.39
M 901	METER	5730-1411	24655	5730-1411
P 501	LAMP FLANGE BASE 6V 0.2A 1000H	5600-0300	71744	CM-328
PL 501	RECEPTACLE POWER IEC STD 6A 250V	4240-0210	24655	4240-0210
Q 503	TRANSISTOR 2N3740	8210-1121	04713	2N3740
Q 504	TRANSISTOR 40250	8210-1095	02735	40250
Q 901	TRANSISTOR 2N3055	8210-1097	13327	2N3055
R 901	RES FLM 142.3 OHM 1PCT100PPM1/4W	6619-3342	24655	6619-3342
R 902	RES FLM 96.2 OHM 1PCT 100PPM1/4W	6619-3341	24655	6619-3341
R 903	RES FLM 142.3 OHM 1PCT100PPM1/4W	6619-3342	24655	6619-3342
R 904	RES FLM 96.2 OHM 1PCT 100PPM1/4W	6619-3341	24655	6619-3341
R 905	RES FLM 142.3 OHM 1PCT100PPM1/4W	6619-3342	24655	6619-3342
R 906	RES FLM 96.2 OHM 1PCT 100PPM1/4W	6619-3341	24655	6619-3341
R 907	RES FLM 142.3 OHM 1PCT100PPM1/4W	6619-3342	24655	6619-3342
R 908	RES FLM 96.2 OHM 1PCT 100PPM1/4W	6619-3341	24655	6619-3341
R 909	RES FLM 142.3 OHM 1PCT100PPM1/4W	6619-3342	24655	6619-3342
R 910	RES FLM 96.2 OHM 1PCT 100PPM1/4W	6619-3341	24655	6619-3341
R 911	RES FLM 142.3 OHM 1PCT100PPM1/4W	6619-3342	24655	6619-3342
R 912	RES FLM 96.2 OHM 1PCT 100PPM1/4W	6619-3341	24655	6619-3341
R 913	RES FLM 142.3 OHM 1PCT100PPM1/4W	6619-3342	24655	6619-3342
R 914	RES FLM 96.2 OHM 1PCT 100PPM1/4W	6619-3341	24655	6619-3341
R 915	RES FLM 142.3 OHM 1PCT100PPM1/4W	6619-3342	24655	6619-3342
R 916	RES FLM 65.8 OHM 1PCT 100PPM1/4W	6619-3340	24655	6619-3340
R 917	POT COMP KNOB 1K OHM 10 PCT LIN	6000-0300	01121	JAIN056S102UZ
R 919	RES COMP 30 OHM 5PCT 1/4W D	6099-0305	81349	RCR07G300J
R 920	RES COMP 30 OHM 5PCT 1/4W D	6099-0305	81349	RCR07G300J
R 921	RES COMP 30 OHM 5PCT 1/4W D	6099-0305	81349	RCR07G300J
R 922	RES COMP 30 OHM 5PCT 1/4W D	6099-0305	81349	RCR07G300J
R 923	RES COMP 100 OHM 5PCT 1/2W	6100-1105	81349	RCR20G101J
R 924	THERMISTOR 100 OHM 10 PCT	6740-1606	15801	LB21J1
R 925	RSTR COMP 22 OHMS 5PCT 4W	6095-0022	01121	HM2205
S 501	SWITCH TOGGLE 2POS DPST STEADY	7910-1300	04009	83053
S 502	SWITCH SLIDE 2 POS DPDT STEADY S	7910-0832	82389	11A-1266
S 901	SWITCH ROTARY ASM	7890-5300	24655	7890-5300
SO 901	SOCKET TUBE 7 CONT	7530-0200	71785	TS102001
T 501	TRANSFORMER POWER	0485-4037	24655	0485-4037
V 901	TUBE VACUUM 5722	8380-5722	13148	5722

ELECTRICAL PARTS LIST

VIDEO AMPLIFIER CIRCUIT P/N 1383-2731

REFDES	DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
C 301	CAP ALUM 200 UF 6V	4450-2610	56289	30D207G006
C 302	CAP ALUM 100 UF 15V	4450-2800	56289	30D107G015
C 303	CAP ALUM 200 UF 6V	4450-2610	56289	30D207G006
C 304	CAP ALUM 100 UF 15V	4450-2800	56289	30D107G015
C 305	CAP CER DISC 51PF 5PCT 500V	4404-0515	72982	0831082Z5D00510J
C 306	CAP CER DISC 51PF 5PCT 500V	4404-0515	72982	0831082Z5D00510J
C 307	CAP ALUM 200 UF 6V	4450-2610	56289	30D207G006
C 308	CAP TANT 330 UF 20PCT 6V	4450-5707	56289	150D337X0006S2
C 309	CAP TANT 330 UF 20PCT 6V	4450-5707	56289	150D337X0006S2
C 310	CAP ALUM 200 UF 6V	4450-2610	56289	30D207G006
C 311	CAP ALUM 200 UF 6V	4450-2610	56289	30D207G006
C 312	CAP CER MONO 0.47UF 20PCT 50VGP	4400-2054	72982	8131M050651047M
C 313	CAP CER MONO 0.47UF 20PCT 50VGP	4400-2054	72982	8131M050651047M
C 314	CAP ALUM 200 UF 6V	4450-2610	56289	30D207G006
C 315	CAP ALUM 600 UF 3V	4450-5589	56289	30D607G003
C 316	CAP TANT 22 UF 20PCT 15V	4450-5300	56289	150D226X0015B2
C 317	CAP TANT 22 UF 20PCT 15V	4450-5300	56289	150D226X0015B2
C 318	CAP ALUM 100 UF 15V	4450-2800	56289	30D107G015
C 319	CAP CER MONO 0.1UF 20PCT 50VGP	4400-2050	72982	8131-M050-651-104M
C 320	CAP CER MONO 0.1UF 20PCT 50VGP	4400-2050	72982	8131-M050-651-104M
C 321	CAP CER MONO 0.1UF 20PCT 50VGP	4400-2050	72982	8131-M050-651-104M
C 322	CAP CER MONO 0.1UF 20PCT 50VGP	4400-2050	72982	8131-M050-651-104M
C 323	CAP CER DISC 62PF 5PCT 500V	4404-0625	72982	0831082Z5P00620J
C 324	CAP CER DISC 27PF 5PCT 500V	4404-0275	72982	0831082Z5D00270J
CR 301	DIODE 1N4151 75PIV IR.1UA SI	6082-1001	14433	1N3604
CR 302	DIODE 1N4151 75PIV IR.1UA SI	6082-1001	14433	1N3604
L 301	CHOKE MOLDED 0.15 UH 10 PCT D	4300-0101	24655	4300-0101
L 302	CHOKE MOLDED 0.15 UH 10 PCT D	4300-0101	24655	4300-0101
L 303	CHOKE MOLDED 10.0 UH 10PCT	4300-2200	99800	1537-36
Q 301	TRANSISTOR 2N3640	8210-1129	07263	2N3640
Q 302	TRANSISTOR 2N3646	8210-1293	07263	PN3646
Q 303	TRANSISTOR 2N3646	8210-1293	07263	PN3646
Q 304	TRANSISTOR 2N3640	8210-1129	07263	2N3640
Q 305	TRANSISTOR 2N3646	8210-1293	07263	PN3646
Q 306	TRANSISTOR 2N3646	8210-1293	07263	PN3646
Q 307	TRANSISTOR 2N3250	8210-1089	04713	2N3250
Q 308	TRANSISTOR	8210-1168	24655	8210-1168
Q 309	TRANSISTOR	8210-1168	24655	8210-1168
Q 310	TRANSISTOR 2N3563	8210-1066	07263	2N3563
R 301	RES COMP 470 OHM 5PCT 1/2W	6100-1475	81349	RCR20G471J
R 302	RES COMP 510 OHM 5PCT 1/2W D	6100-1515	81349	RCR20G511J
R 303	RES FLM 309 OHM 1 PCT 1/8W	6250-0309	81349	RN55D3090F
R 304	RES FLM 51.1 OHM 1 PCT 1/8W	6250-9511	81349	RN55D51R1F
R 305	RES COMP 510 OHM 5PCT 1/2W D	6100-1515	81349	RCR20G511J
R 306	RES COMP 220 OHM 5PCT 1/2W	6100-1225	81349	RCR20G221J
R 307	RES COMP 910 OHM 5PCT 1/2W D	6100-1915	81349	RCR20G911J
R 308	RES COMP 5.1 K OHM 5PCT 1/2W D	6130-2515	81349	RCR20G512J
R 309	RES COMP 5.1 K OHM 5PCT 1/2W D	6100-2515	81349	RCR20G512J

ELECTRICAL PARTS LIST (cont)

VIDEO AMPLIFIER CIRCUIT P/N 1383-2731

REFDES	DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
R 310	RES COMP 130 OHM 5PCT 1/2W D	6100-1135	81349	RCR20G131J
R 312	RES COMP 47 OHM 5PCT 1/2W	6100-0475	81349	RCR20G470J
R 313	RES COMP 680 OHM 5PCT 1/2W	6130-1685	81349	RCR20G681J
R 314	RES FLM 309 OHM 1 PCT 1/8W	6250-0309	81349	RN55D3090F
R 315	RES FLM 51.1 OHM 1 PCT 1/8W	6250-9511	81349	RN55D51R1F
R 316	RES COMP 510 OHM 5PCT 1/2W D	6100-1515	81349	RCR20G511J
R 317	RES COMP 110 OHM 5PCT 1/2W D	6100-1115	81349	RCR20G111J
R 318	RES COMP 470 OHM 5PCT 1/2W	6100-1475	81349	RCR20G471J
R 319	RES COMP 2.4 K OHM 5PCT 1/2W D	6100-2245	81349	RCR20G242J
R 320	RES COMP 2.4 K OHM 5PCT 1/2W D	6100-2245	81349	RCR20G242J
R 321	RES COMP 47 OHM 5PCT 1/2W	6100-0475	81349	RCR20G470J
R 322	POT COMP TRM 50 OHM 20PCT 1T	6040-0050	01121	YR500M
R 323	RES COMP 200 OHM 5PCT 1W	6110-1205	81349	RCR32G201J
R 324	RES FLM 51.1 OHM 1 PCT 1/8W	6250-9511	81349	RN55D51R1F
R 325	RES FLM 10 OHM 1 PCT 1/8W	6250-9100	81349	RN55D10R0F
R 326	RES COMP 200 OHM 5PCT 1/2W D	6100-1205	81349	RCR20G201J
R 327	POT COMP TRM 500 OHM 20PCT 1T	6040-0300	01121	YR501M
R 329	RES FLM 75 OHM 1 PCT 1W	6550-9750	81349	RN75D75R0F
R 330	RES FLM 536 OHM 1 PCT 1/8W	6250-0536	81349	RN55D5360F
R 331	RES FLM 464 OHM 1 PCT 1/8W	6250-0464	81349	RN55D4640F
R 332	RES COMP 43 OHM 5PCT 1/2W D	6100-0435	81349	RCR20G430J
R 333	RES COMP 680 OHM 5PCT 1/2W	6100-1685	81349	RCR20G681J
R 334	RES COMP 62 OHM 5PCT 1/2W D	6100-0625	81349	RCR20G620J
R 335	THERMISTOR 250 OHM 10PCT	6740-1604	15801	LA23J2
R 336	RES COMP 910 OHM 5PCT 1/2W D	6100-1915	81349	RCR20G911J
R 337	RES COMP 47 OHM 5PCT 1/2W	6100-0475	81349	RCR20G470J
R 338	RES COMP 4.7 OHM 5PCT 1/4W	6099-9475	81349	RCR07G4R7J

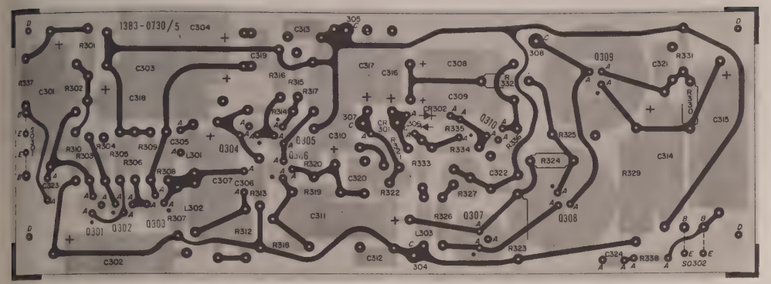
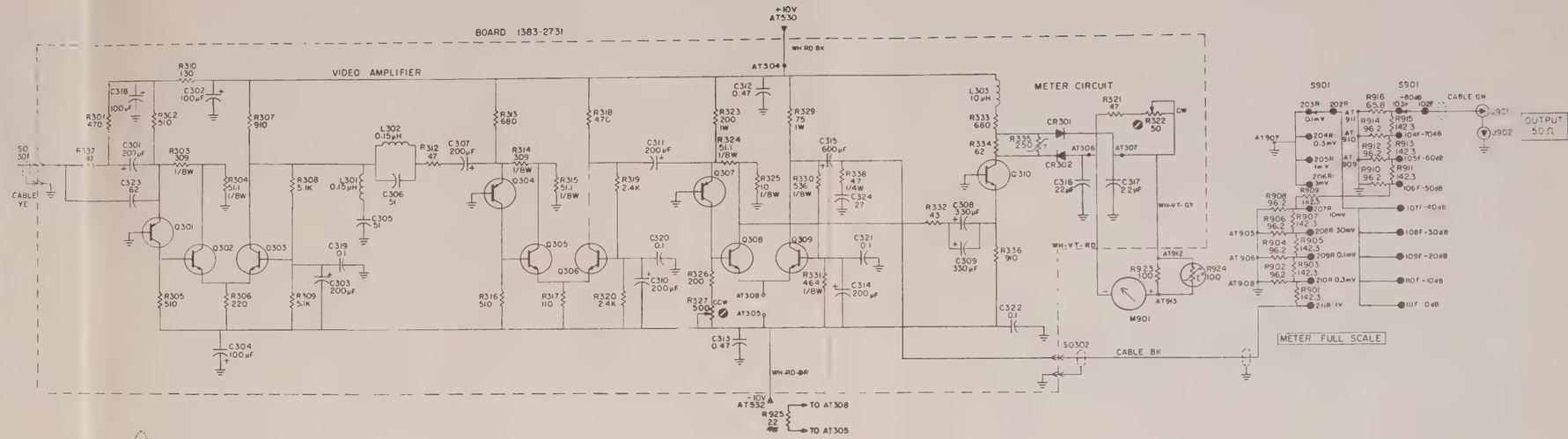
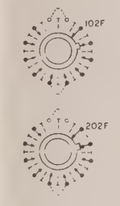


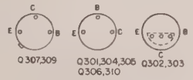
Figure 8-8. Etched-circuit board assembly for the video amplifier and attenuator. The complete board is P/N 1383-2731.

NOTE: The number appearing on the foil side is not the part number. The dot on the foil at the transistor socket indicates the collector lead.





SWITCHING DIAGRAM S901



BOTTOM VIEW OF TRANSISTORS

NOTE UNLESS SPECIFIED	
1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.	5. RESISTANCE IN OHMS K - 1000 OHMS M - 1 MEGOHM
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK	6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS. LESS THAN ONE IN MICROFARADS.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.	7. ◯ KNOB CONTROL 8. ◯ SCREWDRIVER CONTROL
4. RESISTORS 1/2 WATT.	9. AT - ANCHOR TERMINAL 10. TP - TEST POINT

Rotary switch sections are shown as viewed from the panel end of the shaft. The first digit of the contact number refers to the section. The section nearest the panel is 1, the next section back is 2, etc. The next two digits refer to the contact. Contact 01 is the first position clockwise from a strut screw (usually the screw above the locating key), and the other contacts are numbered sequentially (02, 03, 04, etc), proceeding clockwise around the section. A suffix F or R indicates that the contact is on the front or rear of the section, respectively.

Figure 8-9. Schematic circuit diagram of the video amplifier and attenuator.

ELECTRICAL PARTS LIST

10V REGULATOR CIRCUIT P/N 1383-2741

REFDES	DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
C 509	CAP CER DISC .01UF 80/20PCT 500VU	4406-3109	72982	0811082Z5U00103Z
C 510	CAP CER DISC .01UF 80/20PCT 500VU	4406-3109	72982	0811082Z5U00103Z
C 511	CAP ALUM 200 UF 6V	4450-2610	56289	30D207G006
C 512	CAP CER DISC 470PF 5PCT 500V	4404-1475	72982	0831082Z5D00471J
C 513	CAP ALUM 100 UF 15V	4450-2800	56289	30D107G015
C 514	CAP CER MONO 0.47UF 20PCT 50VGP	4430-2054	72982	8131M0506510474M
C 515	CAP ALUM 200 UF 6V	4450-2610	56289	30D207G006
C 516	CAP CER MONO 0.1UF 20PCT 50VGP	4430-2050	72982	8131-M050-651-104M
C 517	CAP CER MONO 0.1UF 20PCT 50VGP	4430-2050	72982	8131-M050-651-104M
C 518	CAP CER MONO 0.47UF 20PCT 50VGP	4400-2054	72982	8131M0506510474M
C 520	CAP ALUM 15 UF 15V	4450-3700	56289	30D156G015
CR 513	DIODE 1N4154 25PIV IR.1UA SI	6082-1012	14433	1N4154
CR 514	ZENER 1N750A 4.7V 5PCT .4W	6083-1028	14433	1N750A
CR 515	DIODE 1N4154 25PIV IR.1UA SI	6082-1012	14433	1N4154
Q 501	TRANSISTOR 2N3905	8210-1114	04713	2N3905
Q 502	TRANSISTOR 2N3903	8210-1132	04713	2N3903
Q 504	TRANSISTOR 2N3905	8210-1114	04713	2N3905
Q 505	TRANSISTOR 2N3903	8210-1132	04713	2N3903
R 505	RES WW MOLDED 2.2 OHM 10 PCT 2W	6760-9229	75042	BWH 2.2 OHM 10PCT
R 506	RES COMP 33 OHM 5PCT 1/2W	6100-0335	81349	RCR20G330J
R 507	RES COMP 680 OHM 5PCT 1/2W	6100-1685	81349	RCR20G681J
R 508	RES COMP 33 OHM 5PCT 1/2W	6100-0335	81349	RCR20G330J
R 509	RES COMP 330 OHM 5PCT 1/2W	6100-1335	81349	RCR20G331J
R 510	RES COMP 100 OHM 5PCT 1/2W	6100-1105	81349	RCR20G101J
R 511	RES COMP 510 OHM 5PCT 1/2W D	6100-1515	81349	RCR20G511J
R 512	RES COMP 330 OHM 5PCT 1/2W	6100-1335	81349	RCR20G331J
R 513	RES COMP 330 OHM 5PCT 1/2W	6100-1335	81349	RCR20G331J
R 514	RES COMP 330 OHM 5PCT 1/2W	6100-1335	81349	RCR20G331J
R 515	RES COMP 33 OHM 5PCT 1/2W	6100-0335	81349	RCR20G330J
R 516	RES COMP 680 OHM 5PCT 1/2W	6100-1685	81349	RCR20G681J
R 517	RES COMP 33 OHM 5PCT 1/2W	6100-0335	81349	RCR20G330J
R 518	RES WW MOLDED 2.2 OHM 10 PCT 2W	6760-9229	75042	BWH 2.2 OHM 10PCT
R 519	RES COMP 75 OHM 5PCT 1/2W D	6100-0755	81349	RCR20G750J
R 520	RES COMP 1.5 K 5PCT 1/2W	6100-2155	81349	RCR20G152J
R 521	RES FLM 5.11K 1 PCT 1/4W	6350-1511	81349	RN60D5111F
R 522	RES COMP 1.6 K OHM 5PCT 1/2W D	6100-2165	81349	RCR20G162J
R 523	RES FLM 4.42K 1 PCT 1/4W	6350-1442	81349	RN60D4421F
R 524	RES COMP 100 OHM 5PCT 1/2W	6100-1105	81349	RCR20G101J
R 525	POT WW TRM 1K OHM 10 PCT 1T	6056-0138	24655	6056-0138

ELECTRICAL PARTS LIST

POWER SUPPLY CIRCUIT P/N 1383-2750

REFDES	DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
C 503	CAP ALUM 3600-1800-1800 UF 10V	4450-5609	56289	60D 10V
C 504	CAP ALUM 450-225-225 UF 100V U	4450-4000	56289	60D 100V
C 505	CAP ALUM 1500-750-750 UF 25V	4450-0700	56289	60D 25V
C 506	CAP ALUM 1500-750-750 UF 25V	4450-0700	56289	60D 25V
C 507	CAP ALUM 1500-750-750 UF 25V	4450-0700	56289	60D 25V
C 508	CAP ALUM 1500-750-750 UF 25V	4450-0700	56289	60D 25V
CR 501	RECT 1N4140 100PIV 3A SI A1XM	6081-1014	14433	1N4140
CR 502	RECT 1N4140 100PIV 3A SI A1XM	6081-1014	14433	1N4140
CR 503	RECT 1N4140 100PIV 3A SI A1XM	6081-1014	14433	1N4140
CR 504	RECT 1N4140 100PIV 3A SI A1XM	6081-1014	14433	1N4140
CR 505	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 506	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 507	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 508	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 509	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 510	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 511	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 512	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
R 501	RES COMP 7.5 K OHM 5PCT 1/2W D	6100-2755	81349	RCR20G752J
R 502	RES COMP 620 OHM 5PCT 1/2W D	6100-1625	81349	RCR20G621J
R 503	RES WW MOLDED 2.7 OHM 10 PCT 2W	6760-9279	75042	BWH 2.7 OHM 10PCT
R 504	RES WW MOLDED 2.7 OHM 10 PCT 2W	6760-9279	75042	BWH 2.7 OHM 10PCT

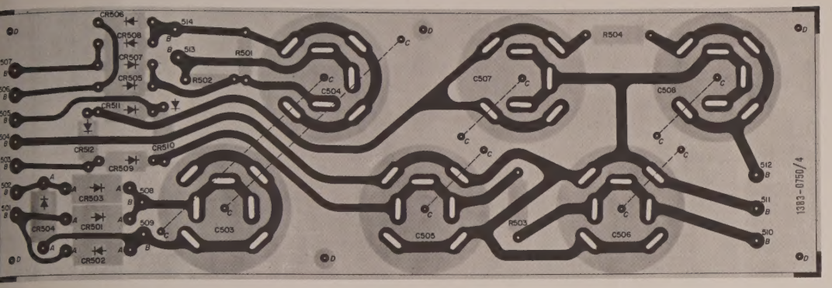


Figure 8-10. Etched-circuit-board assembly for the power-supply. The complete board is P/N 1383-2750.

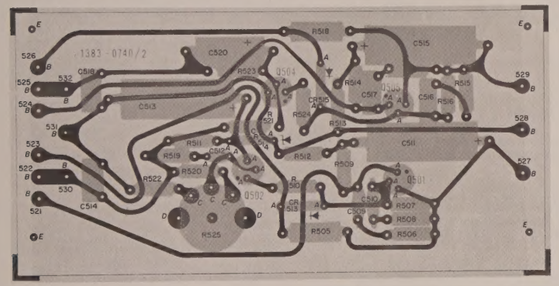


Figure 8-11. Etched-circuit-board assembly for the ±10 V regulator circuit. The complete board is P/N 1383-2741.

NOTE: The number appearing on the foil side is not the part number. The dot on the foil at the transistor socket indicates the collector lead.

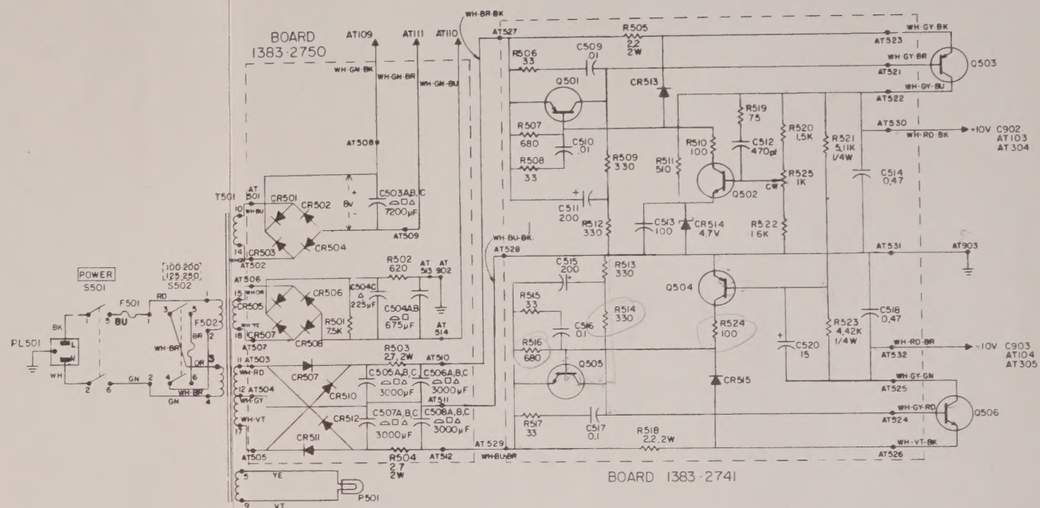


Figure 8-12. Schematic circuit diagram of the power supply.

NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K: 1000 OHMS M: 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS. LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL.
10. TP - TEST POINT

GenRad 300 BAKER AVENUE, CONCORD, MASSACHUSETTS 01742

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